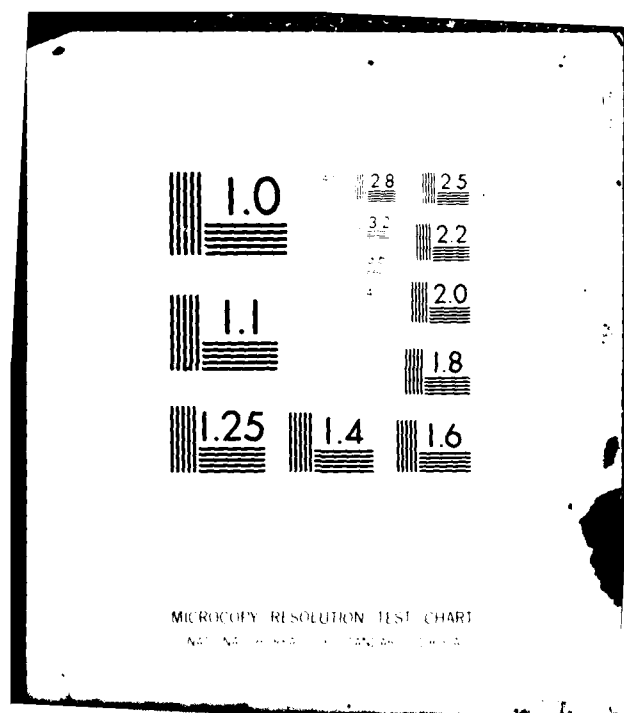


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MICROWAVE LANDING SYSTEM (MLS) CHANNEL PLANS AND TRAFFIC LOADIN--ETC(U)  
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Systems Research &  
Development Service  
Washington, D.C. 20591

# Microwave Landing System (MLS) Channel Plans and Traffic Loading

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Electromagnetic Compatibility Analysis Center  
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Final Report

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Federal Aviation Administration



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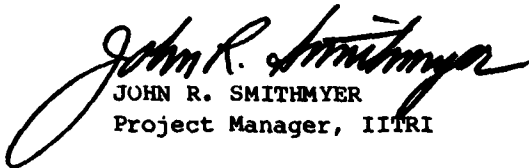
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PREFACE

The Electromagnetic Compatibility Analysis Center (ECAC) is a Department of Defense facility, established to provide advice and assistance on electromagnetic compatibility matters to the Secretary of Defense, the Joint Chiefs of Staff, the military departments and other DoD components. The center, located at North Severn, Annapolis, Maryland 21402, is under policy control of the Assistant Secretary of Defense for Communication, Command, Control, and Intelligence and the Chairman, Joint Chiefs of Staff, or their designees, who jointly provide policy guidance, assign projects, and establish priorities. ECAC functions under the executive direction of the Secretary of the Air Force and the management and technical direction of the Center are provided by military and civil service personnel. The technical support function is provided through an Air Force sponsored contract with the IIT Research Institute (IITRI).

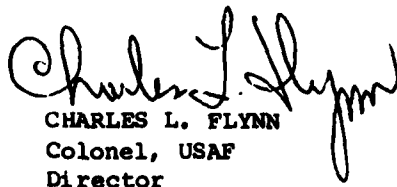
This report was prepared for the Systems Research and Development Service of the Federal Aviation Administration in accordance with Interagency Agreement DOT-FA70WAL-175, as part of AF Project 649E under Contract F-19628-80-C-0042, by the staff of the IIT Research Institute at the Department of Defense Electromagnetic Compatibility Analysis Center.

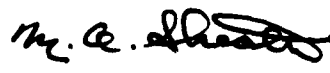
To the extent possible, all abbreviations and symbols used in this report are taken from American Standards Y10.19 (1967) "Units Used in Electrical Science and Electrical Engineering" issued by the USA Standards Institute.

  
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# English/Metric Conversion Factors

## Length

To From	Cm	m	Km	in	ft	s mi	nmi
Cm	1	0.01	$1 \times 10^{-5}$	0.3937	0.0328	$6.21 \times 10^{-6}$	$5.39 \times 10^{-6}$
m	100	1	0.001	39.37	3.281	0.0006	0.0005
Km	100,000	1000	1	39370	3281	0.6214	0.5395
in	2.540	0.0254	$2.54 \times 10^{-5}$	1	0.0833	$1.58 \times 10^{-5}$	$1.37 \times 10^{-5}$
ft	30.48	0.3048	$3.05 \times 10^{-4}$	12	1	$1.89 \times 10^{-4}$	$1.64 \times 10^{-4}$
S mi	160,900	1609	1.609	63360	5280	1	0.8688
nmi	185,200	1852	1.852	72930	6076	1.151	1

## Area

To From	Cm <sup>2</sup>	m <sup>2</sup>	Km <sup>2</sup>	in <sup>2</sup>	ft <sup>2</sup>	S mi <sup>2</sup>	nmi <sup>2</sup>
Cm <sup>2</sup>	1	0.0001	$1 \times 10^{-10}$	0.1550	0.0011	$3.86 \times 10^{-11}$	$5.11 \times 10^{-11}$
m <sup>2</sup>	10,000	1	$1 \times 10^{-6}$	1550	10.76	$3.86 \times 10^{-7}$	$5.11 \times 10^{-7}$
Km <sup>2</sup>	$1 \times 10^{10}$	$1 \times 10^6$	1	$1.55 \times 10^9$	$1.08 \times 10^7$	0.3861	0.2914
in <sup>2</sup>	6.452	0.0006	$6.45 \times 10^{-10}$	1	0.0069	$2.49 \times 10^{-10}$	$1.88 \times 10^{-10}$
ft <sup>2</sup>	929.0	0.0929	$9.29 \times 10^{-8}$	144	1	$3.59 \times 10^{-8}$	$2.71 \times 10^{-8}$
S mi <sup>2</sup>	$2.59 \times 10^{10}$	$2.59 \times 10^6$	2.590	$4.01 \times 10^9$	$2.79 \times 10^7$	1	0.7548
nmi <sup>2</sup>	$3.43 \times 10^{10}$	$3.43 \times 10^6$	3.432	$5.31 \times 10^9$	$3.70 \times 10^7$	1.325	1

## Volume

To From	Cm <sup>3</sup>	Liter	m <sup>3</sup>	in <sup>3</sup>	ft <sup>3</sup>	yd <sup>3</sup>	fl oz	fl pt	fl qt	gal
Cm <sup>3</sup>	1	0.001	$1 \times 10^{-6}$	0.0610	$3.53 \times 10^{-5}$	$1.31 \times 10^{-6}$	0.0338	0.0021	0.0010	0.0002
liter	1000	1	0.001	61.02	0.0353	0.0013	33.81	2.113	1.057	0.2642
m <sup>3</sup>	$1 \times 10^6$	1000	1	61,000	35.31	1.308	33,800	2113	1057	264.2
in <sup>3</sup>	16.39	0.0163	$1.64 \times 10^{-5}$	1	0.0006	$2.14 \times 10^{-5}$	0.5541	0.0346	0.0173	0.0043
ft <sup>3</sup>	28,300	28.32	0.0283	1728	1	0.0370	957.5	59.84	0.0173	7.481
yd <sup>3</sup>	765,000	764.5	0.7646	46700	27	1	25900	1616	807.9	202.0
fl oz	29.57	0.2957	$2.96 \times 10^{-5}$	1.805	0.0010	$3.87 \times 10^{-5}$	1	0.0625	0.0312	0.0078
fl pt	473.2	0.4732	0.0005	28.88	0.0167	0.0006	16	1	0.5000	0.1250
fl qt	946.3	0.9463	0.0009	57.75	0.0334	0.0012	32	2	1	0.2500
gal	3785	3.785	0.0038	231.0	0.1337	0.0050	128	8	4	1

## Mass

To From	g	Kg	oz	lb	ton
g	1	0.001	0.0353	0.0022	$1.10 \times 10^{-6}$
Kg	1000	1	35.27	2.205	0.0011
oz	28.35	0.0283	1	0.0625	$3.12 \times 10^{-5}$
lb	453.6	0.4536	16	1	0.0005
ton	907,000	907.2	32,000	2000	1

## Temperature

$$^{\circ}\text{C} = 9/5 (^{\circ}\text{F} - 32)$$

$$^{\circ}\text{F} = 5/9 (^{\circ}\text{C}) + 32$$



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SECTION 1  
INTRODUCTION

BACKGROUND

The International Civil Aviation Organization (ICAO) has selected the Time Reference Scanning Beam (TRSB) Microwave Landing System (MLS) for standardization as the new international, nonvisual, precision approach and landing system. The TRSB MLS uses the aeronautical radio-navigation bands of 5.00-5.25 GHz (C-Band) for angle guidance and 960-1215 MHz (L-Band) for range guidance. A description of the TRSB is contained in the Federal Aviation Administration (FAA) submission to ICAO.<sup>1</sup>

The MLS angle-guidance signal format is based on the TO-FRO scanning-beam technique in which narrow fan beams scan through the coverage volume in alternate directions. The beams scan at high speed and consist of a single, unmodulated, continuous, radio-frequency transmission. In every scanning cycle, the airborne receiver "sees" two pulses. The time interval between the TO and FRO pulses is proportional to the angular position of the aircraft with respect to the runway center line. All functions relative to angle guidance are time-multiplexed on the assigned C-Band radio frequency so that a single receiver-processor channel may process all angle-guidance data. These functions include elevation, azimuth, and flare (optional) angle guidance, missed approach (optional) angle guidance, and auxiliary data.

The currently proposed L-Band MLS/Distance Measuring Equipment (DME) signal format consists of pulse-pairs with specified spacings between pulses. This proposed format is similar to that used by the existing TACAN/DME equipments, but the specific concepts to be used have not been

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<sup>1</sup>Department of Transportation/Federal Aviation Administration, Time Reference Scanning Beam Microwave Landing System, A New Nonvisual Precision Approach and Landing System for International Civil Aviation, Washington, DC, December 1975.

agreed upon internationally. The purpose of the multiplexing of the MLS/DME, commonly referred to as Precision Distance Measurement Equipment (DME/P), and TACAN/DME signals on the same L-Band frequencies is an attempt to accommodate added channels and increased band occupancy without jeopardizing TACAN/DME service.

The constraints that would allow both MLS range and angle-guidance functions to operate compatibly in their respective bands have to be determined prior to full MLS implementation. The major constraints presently of concern to the FAA Spectrum Management Office are those that would affect the assignment of operating frequencies to each C-Band and L-Band MLS function at participating airports, both nationally and worldwide.

The Electromagnetic Compatibility Analysis Center (ECAC) has supported the FAA through C-Band and L-Band equipment tests, the development of an automated MLS channel assignment system, the building of test environments for trial channel assignments, the development of interference thresholds, and the provision of general consultative services over the past 10 years.

#### PAST EFFORTS

In order to establish the compatibility of the MLS DME/P with the existing and future Tactical Air Navigation (TACAN)/DME, the FAA sponsored a DME/P versus TACAN/DME compatibility measurement program in 1976.<sup>2</sup> ECAC was requested to: 1) present and analyze the results of the DME/P versus TACAN/DME compatibility measurement program, and 2) recommend further analyses and measurements regarding DME/P versus TACAN/DME compatibility that would assist the FAA to develop a total MLS channel plan.

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<sup>2</sup>Sutton, Steve, et al., The Susceptibility of Representative TACAN and DME Equipments to Proposed MLS L-Band Precision DME Signal Format, FAA-RD-80-90, Department of Transportation/Federal Aviation Administration, Washington, DC, August 1980.

The DME/P signal format under consideration in 1977 consisted of a pulse pair: the first pulse was specially shaped, and the second pulse was a standard, Gaussian-shaped TACAN/DME pulse. Using varying pulse-repetition frequencies, signal levels, and pulse-pair spacings, this signal format was introduced as interference to TACAN/DME interrogators and transponders to determine their susceptibility to this interference. The measurements showed that interrogators and transponders are affected by both simulated cochannel and adjacent-channel DME/P signals. The effect increased with higher signal rates. For the most susceptible equipment, the effect appeared to be independent of the DME/P pulse-pair spacing. The signal conditions that precluded interference were similar to the existing TACAN/DME siting criteria. Contrary to common opinion, existing TACAN/DME equipment does not provide sufficient rejection to undesired signals of a different pulse-pair spacing to allow indiscriminate use of pulse-multiplexing in the L-Band. These conditions may make it no easier to assign DME/P channels employing a special channel plan than to employ the existing 252 TACAN/DME channels as long as conventional TACAN/DME remain in the operational environment.

In 1979, the Federal Aviation Administration requested that ECAC analytically estimate the interference thresholds of the MLS (C-Band and L-Band) and TACAN/DME equipments so that an initial exercising of the MLS Channel Assignment Model could be performed.<sup>3</sup>

In the MLS/C-Band avionics equipment, the quality of the aircraft guidance signal in the presence of interference is expressed in terms of the Control Motion Noise (CMN) error for the angle-processing channel and the percentage of valid decodes in the preamble/data channel. Associated error budgets were used in analytical procedures to determine the interference thresholds for various MLS configurations for the cases of cochannel and adjacent-channel interference at function level and system level. The constraining threshold values were selected from the system level results as

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<sup>3</sup>Nanda, V., Analytic Determination of Interference Thresholds for Microwave Landing System Equipment and TACAN/DME Equipment, FAA-RD-80-89, Department of Transportation/Federal Aviation Administration, Washington, DC, August 1980.

inputs for exercising the channel assignment model. The desired-to-undesired interference threshold values were used in conjunction with MLS power budgets, antenna patterns, and propagation loss predictions to determine the separation distance required between the C-Band equipments to preclude cochannel and adjacent-channel interference.

Intra- and inter-system interactions were investigated for the L-Band equipment (DME/P, TACAN, DME). The interference cases were categorized as four distinct types according to the frequency and the pulse-pair spacing conditions of the interference source. Determination of the interference thresholds was based on one or more factors such as equipment circuit characteristics, previous test data from the FAA Test Center, equipment performance standards, and ICAO Annex 10 constraints. The separation distance requirements between the interacting equipment were determined on the basis of these thresholds. The constraining interference threshold values for each equipment type were identified for use in the channel assignment model.

The MLS Channel-Assignment Model<sup>4</sup> consists of an intersite analysis routine and a channel-assignment routine. The intersite analysis routine calculates desired-to-undesired signal power ratios (D/U) within each equipment's protected service volume. It then constructs an array containing the worst-case D/U value that exists between each pair of equipments in the environment.

The channel-assignment routine converts the worst-case D/U values to channel separation between equipments and makes channel assignments that satisfy these separation requirements. The channel assignments are performed using a dynamic assignment technique in which the most difficult assignments (those with the least number of available channels) are attempted first. This routine includes an option allowing the user to specify the order of equipment assignment as an alternative to the dynamic technique.

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<sup>4</sup>Hensler, T. and Koshar, A., MLS Channel Assignment Model, FAA-RD-80-91, Department of Transportation/Federal Aviation Administration, Washington, DC, August 1980.

PRESENT EFFORTS

International Standards and Recommended Practices (SARPS) for the MLS angle-guidance subsystem have been developed by Working Group "M"/4 within the ICAO All Weather Operations Panel (AWOP), and SARPS for the range-guidance system are presently evolving through the same process. The ECAC involvement in this development has been, and continues to be, through the FAA.

At the end of FY80, the ICAO AWOP Working Group "M"/4 established a subgroup with multi-national representation for the evaluation of MLS channel plans and the development of a MLS Standard Traffic Loading Model (STLM). The FAA requested ECAC to provide support to the MLS program through participation as a member of this subgroup and by provision of other consultative services to the FAA.

OBJECTIVES

As a result of ECAC's participation in the ICAO AWOP subgroup on MLS Channel Plans and Traffic Loading, ECAC was tasked to:

1. Develop an MLS Standard Traffic Loading Model (STLM) and the determination of pulse traffic within that model
2. Compare the abilities of four proposed channel plans to satisfy the channel requirements within the STLM.

APPROACHTask 1: STLM and Pulse Traffic

A plan to define the details of an MLS STLM and to estimate the magnitude of the maximum pulse loading that may be seen by a DME/P interrogator or transponder was agreed upon in London during the AWOP MLS Channel Plans and Traffic Loading Subgroup meeting (February, 1981). The following is a summary

of the rationale developed at London and used by ECAC to define the STLM and to develop the approach to determine pulse loading.

STLM Definition. It was recognized during the London meeting that the STLM should be large enough to ensure that it includes all MLS and en route facilities that could affect the channel assignment and successful operation of a central facility. Based on the standardized air-to-ground power budget defined by the MLS Concepts Subgroup (Amsterdam, January, 1981) for a desired signal, an assumed maximum effective radiated power (ERP) of 60 dBm from a potential interfering TACAN interrogator, and a conservative propagation prediction for the undesired signal, it was agreed that the STLM should have a radius of approximately 365 nmi. This radius will ensure inclusion of all en route facilities that may contribute to garbling in a DME/P transponder with a threshold 20 dB below the measured peak of the pulses.

After some discussion of constructing an STLM with a uniform distribution of ground facilities or with clusters of runways overlayed with uniformly distributed en route facilities, it was decided at London to use the hypothetical MLS and en route environment already constructed by the United States and centered around the Los Angeles area as the ground facility portion of the STLM. The advantages of using this as the STLM were noted as follows.

1. It represents the most dense area known regarding L-Band requirements.
2. It incorporates existing plans for growth.
3. It includes clusters of runways in large metropolitan areas as well as a distribution of those used by smaller communities.
4. All the locations of the proposed facilities and their characteristics have already been defined in detail sufficient for ready use.
5. It is the same area from which the original MLS STLM was developed.

Although a uniformly distributed STLM may have been cosmetically appealing, it was not known to have any other advantages. A description of the STLM is included in APPENDIX A.

As a result of the discussion of the lack of facilities on the "ocean" side of the model, it was concluded that the Los Angeles derived STLM was realistic and could similarly represent other areas of the world where large metropolitan areas butt against the sea, mountains, or desert, and never extend uninterrupted over long distances in all directions.

The following was decided regarding the distribution of aircraft throughout each transponder's service volume. (Note that there are two options presented here. The first option is described in Items 1 through 4 and a second option is noted in Item 5.)

1. DME/P, Full Capability MLS - An aircraft distribution consistent with T. Hagenberg's Working Paper #16 (Rio, September, 1980), and interrogation rates defined by the MLS Concepts Subgroup (Amsterdam, January, 1981) are listed in TABLE 1 for DME/P service volumes at Full Capability MLS facilities.<sup>a</sup> All aircraft were assumed to be equipped with DME/P interrogators.

TABLE 1

ASSUMED AIRCRAFT DISTRIBUTION WITHIN A FULL CAPABILITY MLS  
DME/P SERVICE VOLUME (OPTION #1)

Location	Number of a/c	Altitude (ft)	Interrogator rate (pp/s)	Number of Interrogators
Ground	50	0	4	1
Takeoff	2	below 2000	40	1
Final Approach	6	below 2000	40	2
Intermediate Approach	5	2000-4000	16	2
Stack	10	above 4000	16	2
Initial Approach	8	above 4000	16	2

<sup>a</sup>The rationale for categorizing facilities "full capability" vs "minimum capability" is included in APPENDIX B.

2. DME/P, Minimum Capability MLS - It was agreed that all MLS service volumes would not be loaded as heavily as noted in TABLE 1, and it was decided that a more realistic situation for general aviation airports or for those airports with a relatively low number of operations would be the lesser distribution represented in TABLE 2. All aircraft were assumed to be equipped with DME/P interrogators.

TABLE 2

ASSUMED AIRCRAFT DISTRIBUTION WITHIN A MINIMUM CAPABILITY MLS  
DME/P SERVICE VOLUME (OPTION #1)

Location	Number of a/c	Altitude (ft)	Interrogator rate (pp/s)	Number of Interrogators
Ground	16	0	4	1
Final approach	4	below 2000	40	2
Inter approach	2	2000-4000	16	1
Stack	2	above 4000	16	1
Initial approach	2	above 4000	16	1

3. High Altitude En route<sup>a</sup> - Forty aircraft were uniformly distributed throughout each high altitude service volume. They were assumed to be of the DME(N) type, interrogating at a rate of 30 pp/s, with an ERP of 60 dBm. Each aircraft was assumed to have two interrogators operating.

4. Low Altitude En route and Terminal En route - The same characteristics were assumed here as for the high altitude en route except that the numbers of aircraft assumed were 30 and 10 aircraft for the low and terminal en routes, respectively.

5. A second option to describe the distribution of air traffic during a transition period from ILS to MLS was discussed and defined to be identical with the one described above for the en route services, but with the following

<sup>a</sup>Sketches of the high altitude, low altitude, and terminal en route service volumes, as they are used in the U.S., are shown in Figure 1.

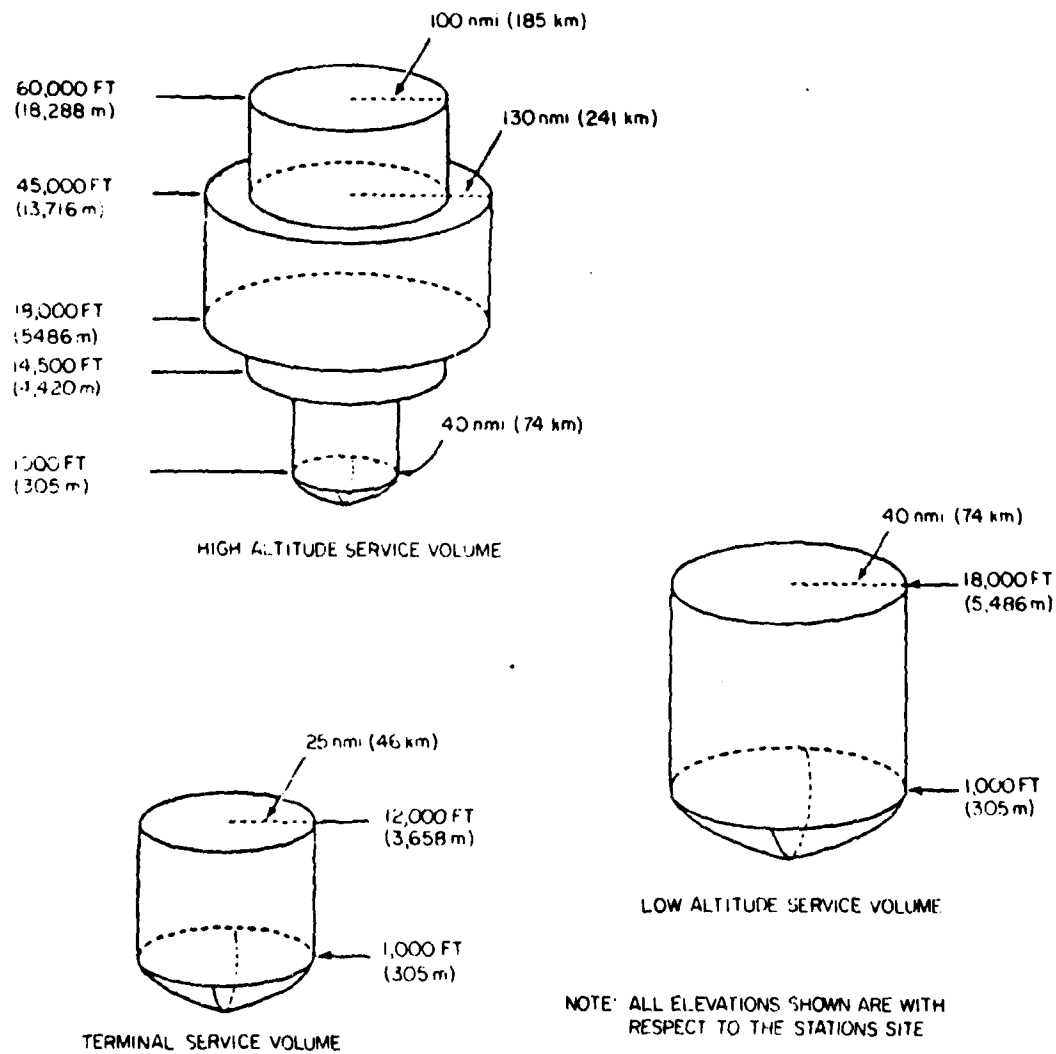


Figure 1. En route service volumes as used in the United States.

noted changes for airport facilities. The main rationale for this option was to establish a higher desired-signal loading on the center facility.

a. At a full capability installation, it was assumed that there is a mix of DME(N) and DME/P equipped aircraft as noted in TABLE 3.

TABLE 3

ASSUMED AIRCRAFT DISTRIBUTION WITHIN A FULL CAPABILITY MLS  
DME/P SERVICE VOLUME (OPTION #2)

Location	Number of a/c	Altitude (ft)	Interrogator rate (pp/s)	Number of Interrogators
Ground	50	0	30	1 DME(N)
Final Approach	6	below 2000	40	2 DME/P
Inter Approach	5	2000-4000	16	2 DME/P
Stack	10	above 4000	16	2 DME/P
Initial Approach	10	above 4000	30	1 DME/P

b. At a minimum capability installation, it was assumed that the aircraft are distributed as in TABLE 2; however, they each were to have only one interrogator of the DME(N) type with an interrogation rate of 30 pp/s.

Pulse rates for TACAN transponders were to be 3600 pp/s and for all other transponders were initially assumed to be 2700 pp/s. Later, to alleviate the potential for ground-to-air traffic loading problems, pulse rates lower than 2700 pp/s were considered. The transmitted power for DME(N) transponders was to be 5 kW<sup>a</sup> with an antenna gain of 7.4 dBi (74.4 dBm ERP). The power budget for DME/P transponders was as defined by the MLS Concepts Subgroup (Amsterdam, January, 1981) and shown in APPENDIX A, TABLE A-3.

<sup>a</sup>En route DME(N) transmitted power was 5 kW for the traffic loading analysis. For later channel assignment tasks, the actual power from the equipment in the Los Angeles area was used, 1 kW or 5 kW.

Pulse Loading Determination. It was recognized at the London meeting that the impact of pulse loading on a victim DME/P receiver was dependent on four principal parameters: 1) numbers of pulses, 2) received power levels, 3) frequency of the interference, and 4) shape of the interfering pulses, i.e., Gaussian versus fast-rise pulses. Any pulse loading determined from the STLM was to reflect these parameters. Specifically, the results were to define:

1. Whether the received pulses were cofrequency, first-, second-, or third-adjacent frequency.

2. The number and type of pulses within each channel (up to third-adjacent) and their received power levels so that a determination could be made as to whether particular receiver thresholds may be disturbed and by how much.

It was decided that a graphic method could be used to determine pulse loading in conjunction with a channel assignment made within the STLM as noted below:

1. Use the ECAC Channel Assignment Model to assign channels to as many facilities as possible in the STLM using only those channel resources that share a common frequency (e.g., 24X, 24W, 24Z). The channel plan proposed by the FRG in Rio de Janeiro (September, 1980) was used in this assignment.

2. Continue to assign channels to as many STLM facilities as possible using only those channel resources within  $\pm 3$  MHz of the frequency used above (see TABLE 4).

3. Calculate the received desired-signal power levels at a DME/P transponder receiver from DME/P equipped aircraft at distances of 22, 7, and 2 nmi.

TABLE 4  
CHANNELS AVAILABLE FOR ASSIGNMENT WITHIN STIM '81<sup>a</sup>

MLS Channel	DME Channel	L-Band Frequency (MHz)	
		Interrogation	Reply
--	21X	1045	982
510	21Z	1045	982
511	21W	1045	982
--	21Y	1045	1108
512	22X	1046	983
513	22Z	1046	983
514	22W	1046	983
515	22Y	1046	1109
--	23X	1047	984
516	23Z	1047	984
517	23W	1047	984
--	23Y	1047	1110
518	24X	1048	985
519	24Z	1048	985
520	24W	1048	985
521	24Y	1048	1111
--	25X	1049	986
522	25Z	1049	986
523	25W	1049	986
--	25Y	1049	1112
524	26X	1050	987
525	26Z	1050	987
526	26W	1050	987
527	26Y	1050	1113
--	27X	1051	988
528	27Z	1051	988
529	27W	1051	988
--	27Y	1051	1114

<sup>a</sup>These channels are a subset of those 200 channels defined in the Rio Channel Plan. See APPENDIX C for a complete description of this plan.

4. Calculate the undesired signal-power levels at that DME/P transponder that would be necessary to disturb threshold measurements made at 0, -6 and -20 dB points on desired signal pulses.

5. Use the vertical radiation pattern from a typical DME antenna and a good propagation loss prediction technique (not free space) and construct equal power lines from the transponder; these power lines represent those power levels calculated in Item 4 above that, if received, could disturb the desired signal threshold (see Figure 2).

6. Overlay on this graph a scale drawing of the service volume in which potentially interfering interrogators may be operating. This scale drawing should have a hypothetical aircraft distribution consistent with TABLES 1 through 3, as appropriate.

7. Count the number of interrogators with the potential for creating interference to each threshold, and then, based on the interrogation rate, the number of potentially disturbing pulses generated in that service volume can be tabulated.

It has been obvious to the members of the AWOP Working Group and to the Channel Plans and Traffic Loading Subgroup members in particular, that the traffic loading problem is a circular one. Traffic loading analysis results may influence the particular MLS DME/P concept chosen by ICAO, that is to establish indirectly the bandwidths, thresholding techniques, pulse-pair spacings, interference protection criteria, number of pulses, channel plan, etc. However, these same parameters are the ones which have the most significant effect on the traffic loading results. Systems using narrow bandwidths, high thresholding techniques, fewer pulse-pair spacings, or fewer pulses are less susceptible to traffic loading problems. Channel plans with channels spread over a larger frequency band would be preferred, from a traffic loading standpoint, to those plans multiplexing many channels on a few frequencies.

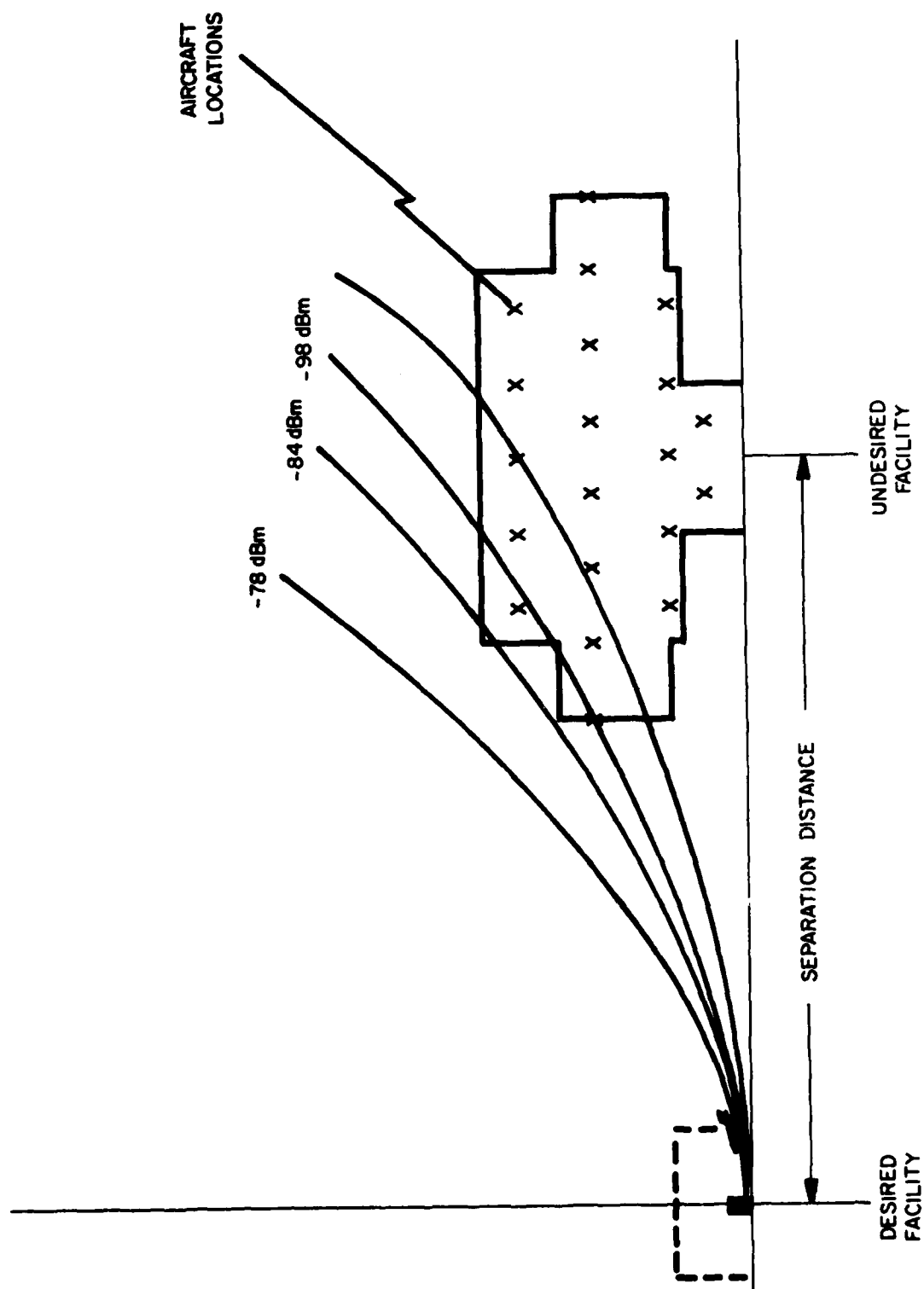


Figure 2. Graphic illustration of pulse loading determination.

In the approach to estimating a conservatively high pulse loading situation, some assumptions were made which may seem unrealistic (e.g., packing as many channel assignments in  $\pm 3$  MHz as possible). It should be recognized that this was done to place an upper bound on the problem. If that upper bound can be accommodated equally by all of the proposed DME/P concepts, then traffic loading need not be considered in the system selection process.

#### Task 2: Channel Plans

The comparison of the abilities of four channel plans to satisfy the channel requirements within the STLM using the fewest channels as well as other criteria was accomplished by using each plan as an input to the MLS Channel Assignment Model and comparing the results. A detailed description of each of the channel plans that was evaluated is contained in APPENDIX C. Interference protection criteria are the same as derived in Reference 3. A matrix of these criteria<sup>a</sup> is shown in APPENDIX A, TABLE A-2.

It should be noted that the STLM contains some DME/P facilities that are pre-assigned. This refers to facilities that are presently functioning with an ILS-DME and have a usable, protected channel assigned to them. In the construction of the STLM, proposed MLS DME/P transponders that replace these existing ILS-DME's will use the same channel assignment, if possible. Other preassigned facilities include the existing en route transponders. In the channel plan evaluation, these en route assignments were not changed.

The results of this activity, in conjunction with Task 1, were the major input into the AWOP MLS Channel Plans and Traffic Loading Subgroup and led to the definition of a more nearly optimum channel plan that could better realize the MLS frequency assignment requirements while reducing the extraneous pulse environment that contributed to an undesirable DME/P garbling potential.

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<sup>a</sup>It should be noted that the effects of high pulse traffic loading were not used to establish these protection criteria.

## SECTION 2

## RESULTS

TASK 1: STLM AND PULSE TRAFFICSTLM Definition

The definition of the airborne portion of the STLM was basically completed at the London meeting as noted in the APPROACH section, and the only effort to be accomplished by ECAC was to select and list a subset of the ground facilities from a previously built, proposed MLS environment centered around the Los Angeles area (see Reference 2). The listing of the ground facilities in the STLM is included in TABLE A-1 of APPENDIX A.

Pulse Loading Determination

The magnitude of the maximum pulse loading situation within the STLM was investigated. The results reflect two types of pulse loading interactions:

1. Undesired interrogations at a transponder from aircraft operating in a different service volume but transmitting on a frequency within the victim transponder's receiver bandwidth (air-to-ground loading).

2. Undesired replies and squitter received at an interrogator from a transponder servicing a different service volume but transmitting on a frequency within the victim interrogator's receiver bandwidth (ground-to-air loading).

3-Pulse System. The interrogation loading on a transponder at El Monte, California, with the desired signal interrogator (aircraft) at 22, 7, and 2 nmi, respectively is provided in TABLES 5, 6, and 7. The loading as noted in the tables is separated vertically into that which comes from cofrequency or adjacent-frequency undesired sources and whether the interfering interrogators are operating in the en route or precision mode.<sup>a</sup> The horizontal

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<sup>a</sup>Precision mode was assumed for aircraft in final approach within 7 nmi of the runway and those in takeoff.

TABLE 5

AIR-TO-GROUND (INTERROGATION) LOADING AT A TRANSPONDER  
FOR A DESIRED-SIGNAL INTERROGATOR AT 22 nmi

Relative Frequency	Interrogator Type-Mode <sup>a</sup>	Number of Interrogations <sup>b</sup> Per Second				
		U/D > -20	U/D > -9	U/D > -6	U/D > -0	U/D > +6
Cofrequency	DME/N-En route	0	0	0	0	0
	DME/P-En route	2592	2496	2496	2400	1712
	DME/P-Precision	1760	1760	1760	1300	1120
± 1 MHz	DME/N-En route	9840	7860	5940	4860	3180
	DME/P-En route	2816	1568	736	176	32
	DME/P-Precision	240	80	80	80	0
± 2 MHz	DME/N-En route	0	0	0	0	0
	DME/P-En route	6128	5024	3632	2720	1312
	DME/P-Precision	1280	1120	1120	560	480
± 3 MHz	DME/N-En route	13140	10740	8700	6120	4260
	DME/P-En route	1488	1152	736	384	96
	DME/P-Precision	0	0	0	0	0
Total Interrogation	DME/N-En route	22980	18600	14640	10980	7440
	DME/P-En route	13024	10240	7600	5680	3152
	DME/P-Precision	3280	2960	2960	1940	1600
Total Individual Pulses <sup>c</sup>		81848	66560	53360	39140	25984

<sup>a</sup>Interfering interrogator type and mode: conventional DME/N; MLS DME/P.

<sup>b</sup>Numbers of interrogations greater than or equal to an undesired-to-desired signal power ratio (U/D) of -20, -9, -6 dB, etc., are represented in each column.

<sup>c</sup>Assuming all aircraft in final approach or takeoff are operating in the precision mode and transmitting 3 pulses per interrogation.

TABLE 6

AIR-TO-GROUND (INTERROGATION) LOADING AT A TRANSPONDER  
FOR A DESIRED-SIGNAL INTERROGATOR AT 7 nmi

Relative Frequency	Interrogator Type-Mode <sup>a</sup>	Number of Interrogations <sup>b</sup> Per Second				
		U/D > -20	U/D > -9	U/D > -6	U/D > -0	U/D > +6
Cofrequency	DME/N-En route	0	0	0	0	0
	DME/P-En route	2368	1424	688	240	64
	DME/P-Precision	1440	400	240	80	80
± 1 MHz	DME/N-En route	4980	2100	1260	840	480
	DME/P-En route	368	16	0	0	0
	DME/P-Precision	80	0	0	0	0
± 2 MHz	DME/N-En route	0	0	0	0	0
	DME/P-En route	2838	976	496	208	64
	DME/P-Precision	800	240	80	80	80
± 3 MHz	DME/N-En route	6780	2760	1740	720	480
	DME/P-En route	576	64	0	0	0
	DME-P-Precision	0	0	0	0	0
Total Interrogation	DME/N-En route	11760	4860	3000	1560	960
	DME/P-En route	6150	2480	1184	448	128
	DME/P-Precision	2320	640	320	160	160
Total Individual Pulses <sup>c</sup>		42780	16600	9328	4496	2656

<sup>a</sup>Interfering interrogator type and mode: conventional DME/N; MLS DME/P.

<sup>b</sup>Numbers of interrogations greater than or equal to an undesired-to-desired signal power ratio (U/D) of -20, -9, -6 dB, etc., are represented in each column.

<sup>c</sup>Assuming all aircraft in final approach or takeoff are operating in the precision mode and transmitting 3 pulses per interrogation.

TABLE 7

AIR-TO-GROUND (INTERROGATION) LOADING AT A TRANSPONDER  
FOR A DESIRED-SIGNAL INTERROGATOR AT 2 nmi

Relative Frequency	Interrogator Type-Mode <sup>a</sup>	Number of Interrogations <sup>b</sup> Per Second				
		U/D > -20	U/D > -9	U/D > -6	U/D > -0	U/D > +6
Cofrequency	DME/N-En route	0	0	0	0	0
	DME/P-En route	1728	448	96	32	0
	DME/P-Precision	240	80	80	80	0
± 1 MHz	DME/N-En route	2760	1020	660	300	180
	DME/P-En route	32	0	0	0	0
	DME/P-Precision	0	0	0	0	0
± 2 MHz	DME/N-En route	0	0	0	0	0
	DME/P-En route	1088	288	96	32	0
	DME/P-Precision	320	80	80	80	0
± 3 MHz	DME/N-En route	4080	840	600	300	180
	DME/P-En route	160	0	0	0	0
	DME-P-Precision	0	0	0	0	0
Total Interrogation	DME/N-En route	6840	1860	1260	600	360
	DME/P-En route	3008	736	192	64	0
	DME/P-Precision	560	160	160	160	0
Total Individual Pulses <sup>c</sup>		21376	5672	3384	1808	720

<sup>a</sup>Interfering interrogator type and mode: conventional DME/N; MLS DME/P.

<sup>b</sup>Numbers of interrogations greater than or equal to an undesired-to-desired signal power ratio (U/D) of -20, -9, -6 dB, etc., are represented in each column.

<sup>c</sup>Assuming all aircraft in final approach or takeoff are operating in the precision mode and transmitting 3 pulses per interrogation.

separation of the data in the tables reflects the relative power level between the desired and undesired interrogations at the transponder receiver input terminals. Note that with the exception of the one row marked "total individual pulses," the numbers in the tables represent interrogations not individual pulses. Also, note that the total number of individual pulses was figured based on a 3-pulse precision mode interrogator being used in the final approach and takeoff phase only.

If one considers a 2-pulse/3-pulse en route/precision system, a transponder receiver with a relatively wide bandwidth ( $\pm 3.5$  MHz) and with a -20 dB threshold level, the maximum number of individual air-to-ground pulses to be considered in a pulse loading analysis is 81,848 (see TABLE 5). If the threshold level is higher than -20 dB (i.e., -18 dB), this maximum number would be a bit smaller, perhaps 79,000 as an estimate by interpolation.

The reply loading on an aircraft operating in the service volume of a DME/P transponder at El Monte, California, for various conditions of "demand loading" is provided in TABLES 8 through 13. Demand loading refers to the potential for the idle reply rate of a transponder to be set at some value below 2700 replies/second (e.g., 1200 or 700), and that this reply rate would increase above that idle rate only when required in order to service additional aircraft in the service volume. The advantage of demand loading is that it could remove a significant amount of unnecessary squitter from the electromagnetic environment.

TABLES 8 through 13 are organized in a similar manner to TABLES 5 through 7 with the loading separated by that which comes from cofrequency or adjacent-frequency sources and also separated by relative desired- and undesired-signal power level at the interrogator input terminals. Note that in TABLES 8 through 13, the loading numbers represent replies and squitter, not individual pulses, with the exception of the last row marked "total individual pulses." Also note that the total number of individual pulses was figured based on a 3-pulse precision mode transponder.

TABLE 8

GROUND-TO-AIR (REPLY) LOADING OF AN AIRCRAFT AT 22 nmi  
 (Assuming an Unloaded DME/N Transponder Reply Rate of  
 3600 Replies/Second for TACAN and 2700 Replies for  
 VOR-DME and an Unloaded DME/P Transponder Reply Rate  
 of 2700 Replies/Second)

Relative Frequency	Interrogator Type-Mode <sup>a</sup>	Number of Replies <sup>b</sup> Per Second				
		U/D > -20	U/D > -9	U/D > -6	U/D > -0	U/D > +6
Cofrequency	DME/N-En route	0	0	0	0	0
	DME/P-En route	18080	11180	6660	6660	6660
	DME/P-Precision	3520	2320	1440	1440	1440
± 1 MHz	DME/N-En route	14400	14400	14400	14400	10800
	DME/P-En route	19740	13320	6900	4760	4760
	DME/P-Precision	4560	2880	1200	640	640
± 2 MHz	DME/N-En route	0	0	0	0	0
	DME/P-En route	18620	17600	13320	11180	11180
	DME/P-Precision	5680	4000	2880	2320	2320
± 3 MHz	DME/N-En route	3600	3600	3600	3600	3600
	DME/P-En route	15460	13080	8560	6420	2140
	DME-P-Precision	3440	3120	2240	1680	560
Total Interrogation	DME/N-En route	18000	18000	18000	18000	14400
	DME/P-En route	71900	55180	35440	29020	24740
	DME/P-Precision	17200	12320	7760	6080	4960
Total Individual Pulses <sup>c</sup>		231400	183320	130160	112280	93160

<sup>a</sup>Interfering transponder type and mode.

<sup>b</sup>Numbers of replies greater than or equal to an undesired-to-desired signal power ratio (U/D) of -20, -9, -6 dB, etc., are represented in each column.

<sup>c</sup>Assuming that DME/P transponders reply with 3 pulses (precision mode) whenever they are interrogated with 3 pulses (aircraft in final approach or takeoff).

TABLE 9

GROUND-TO-AIR (REPLY) LOADING OF AN AIRCRAFT AT 7 nmi  
 (Assuming an Unloaded DME/N Transponder Reply Rate of  
 3600 Replies/Second for TACAN and 2700 Replies for VOR-  
 DME, and an Unloaded DME/P Transponder Reply  
 Rate of 2700 Replies/Second)

Relative Frequency	Interrogator Type-Mode <sup>a</sup>	Number of Replies <sup>b</sup> Per Second				
		U/D ≥ -20	U/D ≥ -9	U/D ≥ -6	U/D ≥ -0	U/D ≥ +6
Cofrequency	DME/N-En route	0	0	0	0	0
	DME/P-En route	11180	6660	6660	0	0
	DME/P-Precision	2320	1440	1440	0	0
± 1 MHz	DME/N-En route	10800	10800	10800	7200	7200
	DME/P-En route	10940	2380	2380	0	0
	DME/P-Precision	2560	320	320	0	0
± 2 MHz	DME/N-En route	0	0	0	0	0
	DME/P-En route	19740	8800	6660	0	0
	DME/P-Precision	4560	2000	1440	0	0
± 3 MHz	DME/N-En route	0	0	0	0	0
	DME/P-En route	8560	0	0	0	0
	DME-P-Precision	2240	0	0	0	0
Total Interrogation	DME/N-En route	10800	10800	10800	7200	7200
	DME/P-En route	50420	17840	15700	0	0
	DME/P-Precision	11680	3760	3200	0	0
Total Individual Pulses <sup>c</sup>		157480	68560	62600	14400	14400

<sup>a</sup>Interfering transponder type and mode.

<sup>b</sup>Numbers of replies greater than or equal to an undesired-to-desired signal power ratio (U/D) of -20, -9, -6 dB, etc., are represented in each column.

<sup>c</sup>Assuming that DME/P transponders reply with 3 pulses (precision mode) whenever they are interrogated with 3 pulses (aircraft in final approach or takeoff).

TABLE 10

GROUND-TO-AIR (REPLY) LOADING OF AN AIRCRAFT AT 22 nmi  
 (Assuming an Unloaded DME/N Transponder Reply Rate  
 of 3600 Replies/Second for TACAN and 2700 Replies for  
 VOR-DME and an Unloaded DME/P Transponder Reply  
 Rate of 1200 Replies/Second)

Relative Frequency	Interrogator Type Mode <sup>a</sup>	Number of Replies <sup>b</sup> Per Second				
		U/D > -20	U/D > -9	U/D > -6	U/D > -0	U/D > +6
Cofrequency	DME/N-En route	0	0	0	0	0
	DME/P-En route	7264	4568	2792	2792	2792
	DME/P-Precision	3520	2320	1440	1440	1440
± 1 MHz	DME/N-En route	14400	14400	14400	14400	10800
	DME/P-En route	8312	5504	2696	1760	1760
	DME/P-Precision	4560	2880	1200	640	640
± 2 MHz	DME/N-En route	0	0	0	00	0
	DME/P-En route	10184	7376	5504	4568	4568
	DME/P-Precision	5680	4000	2880	2320	2320
± 3 MHz	DME/N-En route	3600	3600	3600	3600	3600
	DME/P-En route	6440	5560	3744	2808	936
	DME-P-Precision	3440	3120	2240	1680	560
Total Interrogation	DME/N-En route	18000	18000	18000	18000	14400
	DME/P-En route	32200	23008	14736	11928	10056
	DME/P-Precision	17200	12320	7760	6080	4960
Total Individual Pulses <sup>c</sup>		152000	118976	88752	78096	63792

<sup>a</sup>Interfering transponder type and mode

<sup>b</sup>Numbers of replies greater than or equal to an undesired-to-desired signal power ratio (U/D) of -20, -9, -6 dB etc. are represented in each column.

<sup>c</sup>Assume that DME/P transponders reply with 3 pulses (precision mode) whenever they are interrogated with 3 pulses (aircraft in final approach or takeoff).

TABLE 11

GROUND-TO-AIR (REPLY) LOADING OF AN AIRCRAFT AT 7 nmi  
 (Assuming an Unloaded DME/N Transponder Reply Rate  
 of 3600 Replies/Second for TACAN and 2700 Replies for  
 VOR-DME, and an Unloaded DME/P Transponder Reply  
 Rate of 1200 Replies/Second)

Relative Frequency	Interrogator Type Mode <sup>a</sup>	Number of Replies <sup>b</sup> Per Second				
		U/D > -20	U/D > -9	U/D > -6	U/D > -0	U/D > +6
Cofrequency	DME/N-En route	0	0	0	0	0
	DME/P-En route	4568	2752	2752	0	0
	DME/P-Precision	2320	1440	1440	0	0
± 1 MHz	DME/N-En route	10800	10800	10800	7200	7200
	DME/P-En route	4624	880	880	0	0
	DME/P-Precision	2560	320	320	0	0
± 2 MHz	DME/N-En route	0	0	0	0	0
	DME/P-En route	8312	3688	2752	0	0
	DME/P-Precision	4560	2000	1440	0	0
± 3 MHz	DME/N-En route	0	0	0	0	0
	DME/P-En route	3744	0	0	0	0
	DME-P-Precision	2240	0	0	0	0
Total Interrogation	DME/N-En route	10800	10800	10800	7200	7200
	DME/P-En route	21248	7320	6384	0	0
	DME/P-Precision	11680	3760	3200	0	0
Total Individual Pulses <sup>c</sup>		99136	47520	43968	14400	14400

<sup>a</sup>Interfering transponder type and mode.

<sup>b</sup>Numbers of replies greater than or equal to an undesired-to-desired signal power ratio (U/D) of -20, -9, -6 dB, etc., are represented in each column.

<sup>c</sup>Assuming that DME/P transponders reply with 3 pulses (precision mode) whenever they are interrogated with 3 pulses (aircraft in final approach or takeoff).

TABLE 12

GROUND-TO-AIR (REPLY) LOADING OF AN AIRCRAFT AT 22 nmi  
 (Assuming an Unloaded DME/N Transponder Reply Rate  
 of 3600 Replies/Second for TACAN and 2700 Replies for  
 VOR-DME, and an Unloaded DME/P Transponder Reply  
 Rate of 700 Replies/Second)

Relative Frequency	Interrogator Type Mode <sup>a</sup>	Number of Replies <sup>b</sup> Per Second				
		U/D > -20	U/D > -9	U/D > -6	U/D > -0	U/D > +6
Cofrequency	DME/N-En route	0	0	0	0	0
	DME/P-En route	5264	3568	2252	2252	2252
	DME/P-Precision	3520	2320	1440	1440	1440
± 1 MHz	DME/N-En route	14400	14400	14400	14400	10800
	DME/P-En route	7312	4504	1696	760	760
	DME/P-Precision	4560	2880	1200	640	640
± 2 MHz	DME/N-En route	0	0	0	0	0
	DME/P-En route	9184	6376	4504	3568	3568
	DME/P-Precision	5680	4000	2880	2320	2320
± 3 MHz	DME/N-En route	3600	3600	3600	3600	3600
	DME/P-En route	5440	5060	3744	2808	936
	DME/P-Precision	3440	3120	2240	1680	560
Total Interrogation	DME/N-En route	18000	18000	18000	18000	14400
	DME/P-En route	27200	19508	12196	9388	7516
	DME/P-Precision	17200	12320	7760	6080	4960
Total Individual Pulses <sup>c</sup>		142000	111976	83672	73016	58712

<sup>a</sup>Interfering transponder type and mode.

<sup>b</sup>Numbers of replies greater than or equal to an undesired-to-desired signal power ratio (U/D) of -20, -9, -6 dB, etc., are represented in each column.

<sup>c</sup>Assuming that DME/P transponders reply with 3 pulses (precision mode) whenever they are interrogated with 3 pulses (aircraft in final approach or takeoff).

TABLE 13

GROUND-TO-AIR (REPLY) LOADING OF AN AIRCRAFT AT 7 nmi  
 (Assuming an Unloaded DME/N Transponder Reply Rate  
 of 3600 Replies/Second for TACAN and 2700 Replies  
 for VOR-DME, and an Unloaded DME/P Transponder Reply  
 Rate of 700 Replies/Second)

Relative Frequency	Interrogator Type Mode <sup>a</sup>	Number of Replies <sup>b</sup> Per Second				
		U/D > -20	U/D > -9	U/D > -6	U/D > -0	U/D > +6
Cofrequency	DME/N-En route	0	0	0	0	0
	DME/P-En route	3568	2252	2252	0	0
	DME/P-Precision	2320	1440	1440	0	0
± 1 MHz	DME/N-En route	10800	10800	10800	7200	7200
	DME/P-En route	4124	380	380	0	0
	DME/P-Precision	2560	320	320	0	0
± 2 MHz	DME/N-En route	0	0	0	0	0
	DME/P-En route	7312	3188	2252	0	0
	DME/P-Precision	4560	2000	1440	0	0
± 3 MHz	DME/N-En route	0	0	0	0	0
	DME/P-En route	3744	0	0	0	0
	DME-P-Precision	2240	0	0	0	0
Total Interrogation	DME/N-En route	10800	10800	10800	7200	7200
	DME/P-En route	18748	5820	4884	0	0
	DME/P-Precision	11680	3760	3200	0	0
Total Individual Pulses <sup>c</sup>		94136	44520	40968	14400	14400

<sup>a</sup>Interfering transponder type and mode.

<sup>b</sup>Numbers of replies greater than or equal to an undesired-to-desired signal power ratio (U/D) of -20, -9, -6 dB, etc., are represented in each column.

<sup>c</sup>Assuming that DME/P transponders reply with 3 pulses (precision mode) whenever they are interrogated with 3 pulses (aircraft in final approach or takeoff).

The data reflected in TABLES 8 through 13 indicates that for a 2-pulse/3-pulse en route/precision system, an interrogator with a relatively wide bandwidth while operating in the precision mode ( $\pm 3.5$  MHz) and with a -20 dB threshold level while in final approach or takeoff, the maximum number of individual ground-to-air pulses to be considered in a pulse loading analysis is 157,480 pulses per second (see TABLE 9) when demand loading is not considered. If a demand loaded DME/P system is introduced throughout the STLM, with an idle reply rate of 700 replies/second, the pulse-loading situation reduces to 94,136 pulses per second (see TABLE 13). This situation is somewhat less severe for an aircraft operating in the same service volume but in the en route mode (i.e., narrower bandwidth, higher threshold).

2-Pulse System. The air-to-ground pulse loading for a 2-pulse system, as in the 3-pulse system depends heavily on the receiver bandwidths that would be used. Assuming that a common accuracy constraint would be imposed on each design, it can be assumed that the bandwidths of each system would be the same, and the main difference regarding pulse loading in a 2-pulse system would be due to the "missing" third pulse while in the precision mode.

For a 2-pulse system, the maximum air-to-ground interrogation loading on a DME/P transponder would be 78,568 pulses (as compared to 81,848 for 3-pulse). The ground-to-air reply loading on a DME/P interrogator operating in the final approach (precision) mode or during takeoff would be 145,800 pulses (as compared to 157,480 for 3-pulse), if demand loading is not considered, or 71,656 pulses, if demand loading is set at 700 replies/second.

#### TASK 2: CHANNEL PLANS

Each of the four channel plans tested was able to provide usable, interference-free channel assignments to all the facilities in the STLM using the MLS Channel Assignment Model (see Reference 4).

In the STLM, there are 84 runway facilities that are categorized as pre-assigned, i.e., there is presently a protected ILS-DME L-Band channel assigned

to those 84 facilities. It is expected that each of these facilities will use their existing channel, if possible, whenever an MLS DME/P is installed at that site in the future. Of these 84 facilities, 52 (62%) were able to use that existing ILS-DME channel, but 32 (38%) needed to be reassigned new channels in order to install DME/P transponders and provide interference-free<sup>a</sup> service to aircraft operating within their service volumes. This was true regardless of the channel plan used.

In addition to the pre-assigned facilities in the STLM, there are 110 runway facilities that are proposed for MLS operation in the future, but that presently have no actual DME channel assigned. Of these proposed facilities, 110 (100%) were assigned interference-free<sup>a</sup> channels from the resources of each of the channel plans.

Each channel plan was able to satisfy all the requirements using less than 60 channels (i.e., Seattle - 52, OBC - 53, Rio - 57, Montreal - 54).

Additional insight into the ability of a particular channel plan to provide for future growth was gained by examining the method most probable to be used in implementing the plan and then evaluating the potential for growth after the plan had been theoretically implemented in the STLM.

The channel resources of each plan were prioritized in the following manner and channel assignments were made.

1. The first priority was to use existing ILS-DME channels, if possible, X and Y.
2. The second priority was to use other X and Y channels that had been redefined for MLS use.
3. The last priority was to use the newly defined channels that utilize additional pulse-pair multiplexing.

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<sup>a</sup>Excluding the effects of high traffic loading.

A channel plan's potential for growth was evaluated based on the percentage of the channel plan that had not been used in the assignment process. For example, if the channels were numbered sequentially, if assignments were made with preference given to the lower numbered channels, and if the highest channel number used was #150, then only 25% of that plan was left for growth (in the most congested area). This would be true even though some of the channels less than #150 had not been assigned. They had in fact been "used" as buffer channels to protect against adjacent-channel interference to previously made valid assignments. These buffer channels would not be assignable in the most congested areas of the STM.

The results of this evaluation of growth potential are provided in TABLE 14.

TABLE 14  
CHANNEL PLAN GROWTH POTENTIAL

Plan	% of Channels	
	Used	For Growth
Seattle	34	66
O8C	43	57
Rio	70	30
Montreal	27	73 <sup>a</sup>

It was further recognized that some of the channels identified for growth may not be usable. (They have not been tried.)

The results of this channel plan evaluation were presented to the MLS Subgroup on Channel Plans and Traffic Loading in Amsterdam, August 1981. At the subgroup meeting, a new channel plan was proposed that is considered by the subgroup to have the potential to reduce traffic-loading problems and to make better use of L-Band channels that currently are relatively unused worldwide. It also appears to have a more optimum C-Band/L-Band pairing scheme than do the earlier channel plans. This channel plan is summarized and listed in APPENDIX D. This new plan was not analyzed in this task.

<sup>a</sup>Assuming that eventually the Montreal channel plan could be expanded to a full 200 channels.

SECTION 3  
RESULTS AND RECOMMENDATIONS

RESULTS

The calculated pulse traffic within the STLM is a conservative, upper boundary for the pulse-loading problem. This is based on the conservative assumptions that were built into the STLM and the method used to calculate the results. (MLS facilities are more than double the number of existing ILS facilities -- as many channel assignments as possible were packed into a 7-MHz band centered on the reference channel assignment, and the en route systems were reassigned.)

The ground-to-air traffic-loading results, using a reply rate of 3600 pp/s from TACAN transponders and 2700 pp/s from all other DME(N) and DME/P transponders, appeared too high. Discussions with members of the MLS Concepts Subgroup indicate that pulse loadings greater than 80,000 may reduce the system reply efficiency below 50%. In order to alleviate this problem caused by suspected unnecessary squitter, it may be necessary to reduce the idle squitter rate from DME/P transponders as much as possible and still maintain interoperability with existing interrogators.

Channel planning schemes that utilize more than two new pulse-pair spacings on existing X or Y frequencies to create new channels would produce higher traffic-loading results. This conclusion was based on the traffic-loading results using the Rio Channel Plan which multiplexes W and Z on some of the existing X-channel frequencies. The successful assignment of additional multiplexed channels on the same frequencies would only stress further this undesirable traffic-loading effect.

Further consideration should be given to any method that defines a channel plan without unnecessary multiplexing or implements only those channels of the proposed plans which use single or double multiplexing. Additional multiplexed channels should be reserved for implementation only if

absolutely necessary and if channel assignment techniques can be agreed upon that would prevent traffic-loading problems. These assignment techniques, designed specifically to protect against adverse traffic-loading situations, may render the additional multiplexed channels unusable in the most dense environments, even though this is precisely where additional channels would be required in the future.

The channel-assignment criteria (D/U) used in the traffic-loading analysis and again in the channel plan comparison was based on test data using prototype MLS C-Band and L-Band equipment. Potential changes in these criteria were considered without reaching a definite conclusion. However, it should be noted that both traffic-loading and channel-assignment results were heavily dependent upon certain specific technical characteristics of the DME/P. That is, at least the receiver decoder aperture and selectivity and the transmitted spectral characteristics of ground and airborne equipment contribute to the determination of the D/U protection thresholds used in the channel-assignment process. Without a definition of these characteristics, accurate pulse traffic-loading predictions cannot be completed. At least the decoder aperture, the receiver selectivity, and the transmitter spectral emission characteristics of ground and airborne DME/P equipment should be defined to enable relevant D/U's to be derived and appropriate traffic loading to be finalized.

Based on the trial channel assignments using the four proposed channel plans in which less than 60 channel resources were needed to satisfy proposed MLS requirements related to air traffic predictions through 1990, it may not be necessary to implement all 200 channels of a channel plan for some considerable time.

Considering the traffic-loading results, those channel plans relying almost exclusively on pulse multiplexing to define new channels (such as the Seattle Channel Plan) should not be considered as viable MLS channel plans (see APPENDIX E). In fact, the traffic-loading results point to a need to develop a channel plan with as little multiplexing as possible.

With the exception of the existing ILS-DME channels, the channels to be selected for direct use in an MLS channel plan or for additional multiplexing should be chosen from those existing L-Band channels that are relatively unused worldwide (i.e., Y channels). This is based on the current dense channel use of the X channels, which will tend to deny their use for MLS DME/P. Subsequently, this recommendation was supported by the Working Group "M" whose report on this subject is attached as APPENDIX E.

#### RECOMMENDATIONS

1. An evaluation should be conducted to establish the minimum acceptable idle squitter rate required by existing DME/N interrogators to maintain interoperability with DME/P and DME/N transponders. Consider setting the idle squitter from DME/P transponders near this minimum to reduce the potential for pulse traffic loading problems.

2. Full consideration should be given to the evaluation of all the aspects of the new Amsterdam channel plan proposed by the MLS Channel Plans and Traffic Loading Subgroup. This evaluation should include as a minimum:

a. Re-evaluation of pulse traffic loading concentrating on the potential full implementation of the Y and ZY channels in the future.

b. Performing trial channel assignments within the STLM using different assignment strategies to isolate useless buffer channels and to evaluate the potential for the plan to meet future requirements.

3. Consider the careful implementation of the final MLS channel plan in stages, saving any suspected "problem" channels until last and to be used only if necessary.

4. After the ICAO AWOP Working Group "M" selects a preferred DME/P system concept, channel-assignment criteria (D/U) need to be developed based on the specified pulse shapes, bandwidths, decoder tolerances, receiver selectivities, and emission characteristics.

APPENDIX A  
MLS STANDARD TRAFFIC LOADING MODEL  
(Updated July 1981)

CENTRAL LOCATION: El Monte, California, USA

RADIUS: 365 nmi

NUMBER OF FACILITIES:<sup>a</sup> 327

194 runways (Figure A-1)

66 minimum capability

120 full capability

133 en route (Figure A-2)

41 high altitude

80 low altitude

12 terminal

A detailed listing of the ground facilities within the STLM is contained in TABLE A-1. TABLE A-2 contains the L-Band interference protection criteria from Reference 3 used in the channel assignment process.

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<sup>a</sup>The number of facilities contained in this updated version of STLM ('81) is slightly different than noted in the London minutes. The number in the London minutes was estimated based on "to-scale" measurements from a map, while the number included here was calculated from the actual latitudes and longitudes of the sites.

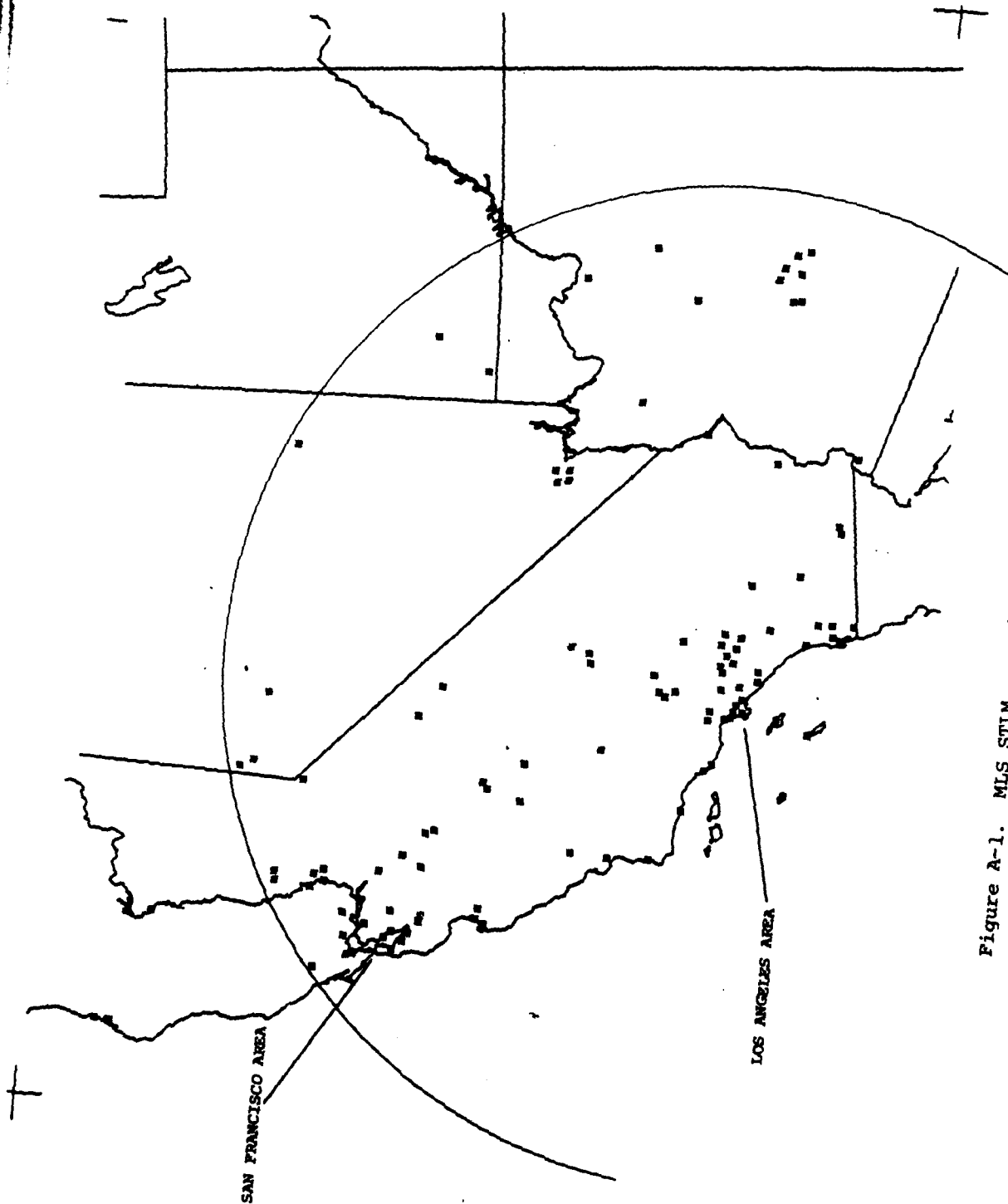


Figure A-1. MLS STIM --- airport facilities.

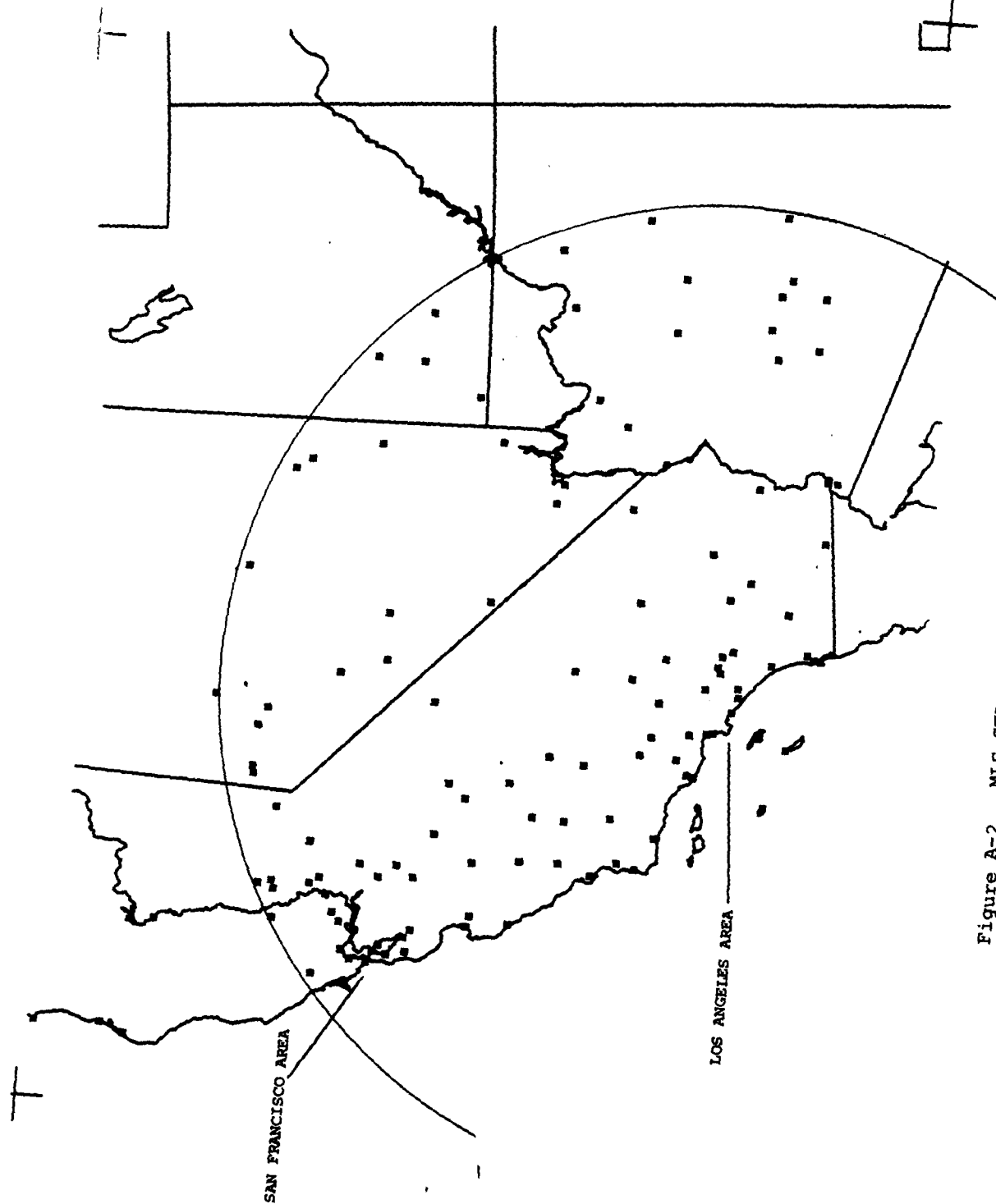


Figure A-2. MLS STIM --- en route facilities.

TABLE A-1  
MLS STLM ('81) FACILITIES  
(Page 1 of 7)

\*\*\* AIRPORT ENVIRONMENT \*\*\*

SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RWY	MLS SERVICE	DME EQUIPMENT	LINK NUM
10	AVALON	/CA AVX	EXS GENERAL	33 24 20 N	118 24 5' W	22	YES	MINIMUM CAP	P DME	
11	AVAJON	/CA AVX	EXS GENERAL	33 24 20 N	118 24 50' W	13	NO	MINIMUM CAP	P DME	
13	BAKERSFELD/CA	BFL	EXS AIR CARR	35 25 46 N	119 03 05 W	30R	YES	FULL CAP	P DME	1
14	BAKERSFELD/CA	BFL	EXS AIR CARR	35 25 46 N	119 03 05 W	12L	YES	FULL CAP	P DME	1
15	BISHOP	/CA BSH	EXS GENERAL	37 22 24 N	118 21 54 W	30	YES	MINIMUM CAP	P DME	
16	BLTYME	/CA BLH	EXS GENERAL	33 37 15 N	114 43 08 W	26	YES	MINIMUM CAP	P DME	
20	BURBANK	/CA BUR	EXS AIR CARR	34 12 00 N	118 21 28 W	33	YES	FULL CAP	P DME	
22	CARLSBAD	/CA CRQ	EXS GENERAL	33 07 41 N	117 16 46 W	24	YES	FULL CAP	P DME	
24	CHINO	/CA CHQ	EXS GENERAL	33 58 15 N	117 38 29 W	21	YES	FULL CAP	P DME	
25	CHINO	/CA CHQ	EXS GENERAL	33 58 15 N	117 38 29 W	8	YES	MINIMUM CAP	P DME	
30	COMPTON	/CA CPM	EXS GENERAL	33 53 24 N	118 14 34 W	25L	YES	MINIMUM CAP	P DME	
31	COMCORD	/CA GER	EXS GENERAL	37 59 23 N	122 03 21 W	19R	YES	FULL CAP	P DME	
32	CORONA	/CA L66	EXS GENERAL	35 53 55 N	117 36 05 W	25	YES	MINIMUM CAP	P DME	
33	CRESCENT/CY/CA	CEC	EXS AIR CARR	41 46 49 N	124 14 07 W	11	YES	FULL CAP	P DME	
35	EL MONTE	/CA ENT	EXS GENERAL	34 05 10 N	118 02 01 W	1	YES	FULL CAP	P DME	
46	FRESNO A	/CA FAT	EXS AIR CARR	36 45 28 N	119 42 57 W	29R	YES	FULL CAP	P DME	2
47	FRESNO A	/CA FAT	EXS AIR CARR	36 45 28 N	119 42 57 W	11L	YES	FULL CAP	P DME	2
48	FRESNO A	/CA FAT	EXS AIR CARR	36 45 28 N	119 42 57 W	7	NO	FULL CAP	P DME	
50	FRESNO CHD/CA	FCH	EXS GENERAL	36 43 57 N	119 49 07 W	30R	YES	MINIMUM CAP	P DME	
51	FRESNO CHD/CA	FCH	EXS GENERAL	36 43 57 N	119 49 07 W	0	NO	MINIMUM CAP	P DME	
52	FULLERTON	/CA FUL	EXS GENERAL	33 52 19 N	117 58 44 W	6	YES	FULL CAP	P DME	
53	FULLERTON	/CA FUL	EXS GENERAL	33 52 19 N	117 58 44 W	24	YES	FULL CAP	P DME	
61	HAUNTHORN	/CA HHR	EXS GENERAL	33 55 23 N	118 20 03 W	25	YES	FULL CAP	P DME	
62	HAUNTHORN	/CA HHR	EXS GENERAL	33 55 23 N	118 20 03 W	7	YES	MINIMUM CAP	P DME	
63	HAYWARD	/CA HND	EXS GENERAL	37 39 34 N	122 07 18 W	10R	YES	FULL CAP	P DME	
64	HAYWARD	/CA HND	EXS GENERAL	37 39 34 N	122 07 18 W	28L	YES	FULL CAP	P DME	
66	IMPERIAL	/CA IPL	EXS AIR CARR	32 50 14 N	115 34 29 W	32	YES	MINIMUM CAP	P DME	
73	LAVERNE	/CA POC	EXS GENERAL	34 05 30 N	117 46 59 W	8	YES	FULL CAP	P DME	
74	LAVERNE	/CA POC	EXS GENERAL	34 05 30 N	117 46 59 W	26	YES	FULL CAP	P DME	
75	LONG BEACH/CA	LJB	EXS GENERAL	34 44 26 N	118 13 04 W	24	YES	MINIMUM CAP	P DME	
76	LIVERMORE	/CA LUK	EXS GENERAL	37 41 41 N	121 49 02 W	7	YES	FULL CAP	P DME	
77	LIVERMORE	/CA LUK	EXS GENERAL	37 41 41 N	121 49 02 W	25	YES	MINIMUM CAP	P DME	
80	LONG BEACH/CA	LGB	EXS AIR CARR	34 49 03 N	118 09 24 W	30	YES	FULL CAP	P DME	
81	LONG BEACH/CA	LGB	EXS AIR CARR	34 49 03 N	118 09 24 W	30	YES	FULL CAP	P DME	
82	LONG BEACH/CA	LGB	EXS AIR CARR	34 49 03 N	118 09 04 W	25R	YES	FULL CAP	P DME	
83	LONG BEACH/CA	LGB	EXS AIR CARR	34 49 03 N	118 09 04 W	7L	YES	FULL CAP	P DME	
84	VAN MUY	/CA VNY	EXS AIR CARR	34 12 35 N	118 29 21 W	18	NO	MINIMUM CAP	P DME	
85	VAN MUY	/CA VNY	EXS AIR CARR	34 12 35 N	118 29 21 W	9	NO	MINIMUM CAP	P DME	
86	VAN MUY	/CA VNY	EXS AIR CARR	34 12 35 N	118 29 21 W	16R	YES	FULL CAP	P DME	
87	VAN MUY	/CA VNY	EXS AIR CARR	34 12 35 N	118 29 21 W	34L	YES	FULL CAP	P DME	
88	LOS ANGELES/CA	LAX	EXS VSTOL	33 56 32 N	118 24 26 W	27	NO	MINIMUM CAP	P DME	
90	LOS ANGELES/CA	LAX	EXS GENERAL	34 15 35 N	118 24 45 W	12	YES	MINIMUM CAP	P DME	
91	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25L	YES	FULL CAP	P DME	3
92	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25R	YES	FULL CAP	P DME	3
93	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	7L	YES	FULL CAP	P DME	4
94	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	7R	YES	FULL CAP	P DME	4
95	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25L	YES	FULL CAP	P DME	5
96	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25R	YES	FULL CAP	P DME	5
97	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	25R	YES	FULL CAP	P DME	6
98	LOS ANGELES/CA	LAX	EXS AIR CARR	33 56 32 N	118 24 26 W	7L	YES	FULL CAP	P DME	6

TABLE A-1

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\*\*\* AIRPORT ENVIRONMENT \*\*\*

SYSTEM ID#	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RWY	MLS SERVICE	DME EQUIPMENT	LINK NUM
103	MAMMOTH LK/CA	MMH	EXS GENERAL	37 37 40 N	118 50 55 W	9	YES	MINIMUM CAP	P DME	
104	MERCED MUN/CA	MCE	EXS AIR CARR	37 17 06 N	120 30 34 W	30	YES	MINIMUM CAP	P DME	7
105	MERCED MUN/CA	MCE	EXS AIR CARR	37 17 06 N	120 30 34 W	12	YES	MINIMUM CAP	P DME	7
106	MARTSVILLE/CA	MTV	EXS AIR CARR	39 05 53 N	121 34 06 W	14	YES	FULL CAP	P DME	
107	MODESTO CV/CA	MOD	EXS AIR CARR	37 37 36 N	120 57 18 W	28R	YES	FULL CAP	P DME	
114	MONTGOMERY P/CA	MNY	EXS AIR CARR	36 35 17 N	121 50 23 W	10	YES	FULL CAP	P DME	
115	MONTGOMERY P/CA	MNY	EXS AIR CARR	36 35 17 N	121 50 53 W	6	YES	FULL CAP	P DME	
118	MAPA CMTY /CA	APC	EXS GENERAL	38 12 48 N	122 16 47 W	18R	YES	FULL CAP BAZ	P DME	
119	MAPA CMTY /CA	APC	EXS GENERAL	38 12 48 N	122 16 47 W	36L	YES	FULL CAP BAZ	P DME	
121	MOVATO /CA	056	EXS GENERAL	38 08 40 N	122 33 25 W	13	YES	MINIMUM CAP	P DME	
123	OAKLAND /CA	OAK	EXS AIR CARR	37 43 19 N	122 13 10 W	28R	YES	FULL CAP BAZ	P DME	
124	OAKLAND /CA	OAK	EXS AIR CARR	37 43 19 N	122 13 10 W	10L	YES	FULL CAP	P DME	
125	OAKLAND /CA	OAK	EXS AIR CARR	37 43 19 N	122 13 10 W	29	YES	FULL CAP	P DME	
126	OAKLAND /CA	OAK	EXS AIR CARR	37 43 19 N	122 13 10 W	11	YES	FULL CAP	P DME	
129	ONTARIO /CA	ONT	EXS AIR CARR	34 03 26 N	117 36 29 W	26	YES	FULL CAP BAZ	P DME	8
130	ONTARIO /CA	ONT	EXS AIR CARR	34 03 26 N	117 36 29 W	8	YES	FULL CAP BAZ	P DME	8
133	OXNARD /CA	OXR	EXS AIR CARR	34 12 04 N	119 12 23 W	25	YES	FULL CAP	P DME	
134	PALM SPRG /CA	PSP	EXS AIR CARR	33 49 36 N	116 30 18 W	30	YES	FULL CAP BAZ	P DME	
135	PALM SPRG /CA	PSP	EXS AIR CARR	33 49 36 N	116 30 18 W	6	YES	FULL CAP	P DME	
136	PALO ALTO /CA	PAO	EXS GENERAL	37 27 40 N	122 06 50 W	12	YES	FULL CAP BAZ	P DME	
137	PASO ROBLES/CA	PRB	EXS AIR CARR	35 40 11 N	120 37 34 W	19	YES	FULL CAP	P DME	
152	RIALTO /CA	L67	EXS GENERAL	34 07 45 N	117 23 30 W	24	YES	MINIMUM CAP	P DME	
153	RIVERSIDE /CA	RAL	EXS AIR CARR	33 57 06 N	117 26 32 W	9R	YES	FULL CAP BAZ	P DME	
154	RIVERSIDE /CA	RAL	EXS AIR CARR	33 57 06 N	117 26 32 W	34	YES	MINIMUM CAP	P DME	
155	SACRAMENTO/CA	SME	EXS AIR CARR	38 41 44 N	121 36 01 W	16L	YES	FULL CAP BAZ	P DME	
156	SACRAMENTO/CA	SME	EXS AIR CARR	38 41 44 N	121 36 01 W	34R	YES	FULL CAP BAZ	P DME	
157	SACRAMENTO/CA	SME	EXS AIR CARR	38 41 44 N	121 36 01 W	6	NO	MINIMUM CAP	P DME	
158	SACRAMENTO/CA	SAC	EXS GENERAL	38 30 47 N	121 29 32 W	2	YES	FULL CAP BAZ	P DME	10
159	SACRAMENTO/CA	SAC	EXS GENERAL	38 30 47 N	121 29 32 W	20	YES	FULL CAP BAZ	P DME	10
160	SALINAS /CA	SNS	EXS GENERAL	36 39 45 N	121 36 20 W	31	YES	FULL CAP BAZ	P DME	
161	SALINAS /CA	SNS	EXS GENERAL	36 39 45 N	121 36 20 W	8	YES	MINIMUM CAP	P DME	
164	SAN CARLOS/CA	SCL	EXS GENERAL	37 30 40 N	122 14 55 W	12	YES	FULL CAP	P DME	
165	IMPERIAL /CA	ITK	EXS AIR CARR	35 39 32 N	117 49 43 W	2	YES	MINIMUM CAP	P DME	
166	SAN DIEGO /CA	SAN	EXS AIR CARR	32 44 01 N	117 11 12 W	27	YES	FULL CAP BAZ	P DME	11
167	SAN DIEGO /CA	SAN	EXS AIR CARR	32 44 01 N	117 11 12 W	9	YES	FULL CAP BAZ	P DME	11
168	SAN DIEGO /CA	SAN	EXS AIR CARR	32 44 01 N	117 11 12 W	13	YES	FULL CAP	P DME	
169	SAN DIEGO /CA	SDM	EXS GENERAL	32 31 20 N	116 58 47 W	8L	YES	MINIMUM CAP	P DME	
170	SAN DIEGO /CA	SDM	EXS GENERAL	32 31 20 N	116 58 47 W	26R	YES	MINIMUM CAP	P DME	
171	SAN DIEGO /CA	SDM	NEW AIR CARR	33 00 00 N	117 01 00 W	25	NO	MINIMUM CAP	P DME	
172	SAN DIEGO /CA	SEE	EXS GENERAL	33 00 00 N	117 01 00 W	7	NO	MINIMUM CAP	P DME	
173	SAN DIEGO /CA	SEE	EXS GENERAL	32 49 33 N	116 58 19 W	27R	YES	FULL CAP BAZ	P DME	12
174	SAN DIEGO /CA	SEE	EXS GENERAL	32 49 33 N	116 58 19 W	9L	YES	FULL CAP BAZ	P DME	12
175	SAN DIEGO /CA	MYF	EXS GENERAL	32 48 58 N	117 08 24 W	10L	YES	FULL CAP BAZ	P DME	
176	SAN DIEGO /CA	MYF	EXS GENERAL	32 48 58 N	117 08 24 W	28R	YES	FULL CAP BAZ	P DME	
179	SAN FRANCISCO	SFO	EXS AIR CARR	37 37 10 N	122 22 28 W	28L	YES	FULL CAP BAZ	P DME	
180	SAN FRANCISCO	SFO	EXS AIR CARR	37 37 10 N	122 22 28 W	28L	YES	FULL CAP BAZ	P DME	
181	SAN FRANCISCO	SFO	EXS AIR CARR	37 37 10 N	122 22 28 W	19L	YES	FULL CAP	P DME	
182	SAN FRANCISCO	SFO	NEW GENERAL	37 40 00 N	122 25 00 W	28	NO	FULL CAP	P DME	
184	SAN JOSE /CA	RHV	EXS GENERAL	37 19 59 N	121 49 07 W	31R	YES	FULL CAP	P DME	
185	SAN JOSE /CA	SJC	EXS AIR CARR	37 21 41 N	121 55 38 W	12R	YES	FULL CAP	P DME	

TABLE A-1

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... AIRPORT ENVIRONMENT ...

SYSTEM ID	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RWY	MLS SERVICE	EQUIPMENT	LINK NUM
186	SAN JOSE /CA	SJC	EXS AIR CARR	37 21 41 N	121 55 38 W	30L	YES	FULL CAP	P DME	
189	SAN LUIS /CA	SLP	EXS GENERAL	35 14 11 N	120 38 24 W	11	YES	MINIMUM CAP	P DME	13
194	SANTA ANA /CA	SNA	EXS AIR-CARR	33 40 32 N	117 52 01 W	19R	YES	FULL-CAP-BAZ	P DME	13
195	SANTA ANA /CA	SNA	EXS AIR CARR	33 40 32 N	117 52 01 W	1L	YES	FULL CAP BAZ	P DME	
196	SANTA ANA /CA	SNA	EXS AIR CARR	33 40 32 N	117 52 01 W	13	NO	MINIMUM CAP	P DME	
199	SANTA ANA /CA	SNA	EXS AIR CARR	34 25 39 N	119 50 17 W	7	YES	FULL CAP	P DME	
200	SANTA ANA /CA	SNA	EXS AIR CARR	34 25 39 N	119 50 17 W	15R	YES	MINIMUM CAP	P DME	14
202	SANTA ANA /CA	SNA	EXS AIR CARR	34 25 39 N	119 50 17 W	12	YES	FULL CAP BAZ	P DME	14
203	SANTA ANA /CA	SNA	EXS AIR CARR	34 25 39 N	119 50 17 W	30	YES	FULL-CAP-BAZ	P DME	
204	SANTA ANA /CA	SNA	EXS AIR CARR	34 25 39 N	119 50 17 W	20	YES	MINIMUM CAP	P DME	
205	SANTA ANA /CA	SNA	EXS GENERAL	34 00 58 N	118 27 03 W	3	YES	FULL CAP BAZ	P DME	
206	SANTA ANA /CA	SNA	EXS GENERAL	34 00 58 N	118 27 03 W	21	YES	FULL CAP-BAZ	P DME	
208	SANTA ANA /CA	SNA	EXS AIR CARR	38 30 32 N	122 48 42 W	32	YES	FULL CAP	P DME	
216	SLACKTANOE/CA	TVL	EXS AIR CARR	38 53 39 N	119 59 42 W	18	YES	MINIMUM CAP	P DME	26
217	SLACKTANOE/CA	TVL	EXS AIR-CARR	38 53 39 N	119 59 42 W	6	NO	MINIMUM CAP	P DME	26
218	STOCKTON /CA	CKK	EXS GENERAL	37 53 39 N	121 14 14 W	11L	YES	FULL CAP	P DME	
219	STOCKTON /CA	CKK	EXS GENERAL	37 53 39 N	121 14 14 W	29R	YES	FULL CAP	P DME	
220	STOCKTON /CA	CKK	EXS GENERAL	37 53 39 N	121 14 14 W	20	NO	MINIMUM CAP	P DME	
224	TORRANCE /CA	TOA	EXS GENERAL	33 48 12 N	118 20 19 W	29R	YES	MINIMUM CAP	P DME	
233	UPLAND /CA	CCB	EXS GENERAL	34 07 00 N	117 41 45 W	24	YES	MINIMUM CAP	P DME	
235	VISALIA /CA	VIS	EXS AIR-CARR	36 19 11 N	119 23 34 W	12	YES	MINIMUM CAP	P DME	16
236	VISALIA /CA	VIS	EXS AIR CARR	36 19 11 N	119 23 34 W	30	YES	MINIMUM CAP	P DME	16
251	CLY /NV	ELY	EXS GENERAL	36 12 45 N	115 11 46 W	7	YES	MINIMUM CAP	P DME	
253	LAS VEGAS /NV	VGT	EXS GENERAL	36 12 45 N	115 11 46 W	12	YES	MINIMUM CAP	P DME	
254	LAS VEGAS /NV	VGT	EXS GENERAL	36 12 45 N	115 11 46 W	19L	YES	FULL CAP-BAZ	P DME	
255	LAS VEGAS /NV	LAS	EXS AIR CARR	36 04 48 N	115 09 08 W	14	YES	FULL CAP	P DME	
257	LAS VEGAS /NV	LAS	EXS AIR CARR	36 04 48 N	115 09 08 W	25	YES	FULL CAP	P DME	
258	RENO /NV	RNO	EXS AIR CARR	39 29 52 N	119 46 03 W	16	YES	FULL CAP BAZ	P DME	18
259	RENO /NV	RNO	EXS AIR CARR	39 29 52 N	119 46 03 W	34	YES	FULL CAP-BAZ	P DME	18
260	RENO /NV	RNO	EXS AIR CARR	39 29 52 N	119 46 03 W	7	YES	FULL CAP	P DME	
261	RENO /NV	RNO	EXS GENERAL	39 40 28 N	119 52 36 W	32	YES	MINIMUM CAP	P DME	
264	CECUM /UT	COC	EXS AIR-CARR	37 42 06 N	113 05 50 W	20	YES	MINIMUM CAP	P DME	
279	FLAGSTAFF /AZ	FLG	EXS AIR CARR	35 08 16 N	111 40 12 W	4	YES	MINIMUM CAP	P DME	
281	GRAND CANYON/AZ	GCN	EXS AIR CARR	35 57 06 N	112 08 46 W	3	YES	MINIMUM CAP	P DME	
282	GRAND CANYON/AZ	GCN	EXS AIR CARR	35 57 06 N	112 08 46 W	19	NO	MINIMUM CAP	P DME	
283	KINGMAN /AZ	IGM	EXS AIR CARR	35 15 24 N	113 56 25 W	17	YES	MINIMUM CAP	P DME	
284	LAKEHAVAS/AZ	LHU	EXS GENERAL	34 27 40 N	114 21 42 W	23	YES	MINIMUM CAP	P DME	
285	LAKEHAVAS/AZ	LHU	EXS GENERAL	34 27 40 N	114 21 42 W	20	YES	MINIMUM CAP	P DME	
286	PHOENIX /AZ	GYR	EXS GENERAL	33 25 22 N	112 22 31 W	3	YES	MINIMUM CAP	P DME	
287	PHOENIX /AZ	PIG	EXS GENERAL	33 28 35 N	111 43 39 W	4	YES	MINIMUM CAP	P DME	
288	MESA /AZ	PIG	EXS GENERAL	33 28 35 N	111 43 39 W	12	NO	MINIMUM CAP	P DME	
290	PAGE MUNI /AZ	PGA	EXS GENERAL	35 55 29 N	111 26 24 W	15	YES	MINIMUM CAP	P DME	
293	PHOENIX /AZ	PHX	EXS AIR CARR	33 26 07 N	112 00 43 W	8R	YES	FULL CAP BAZ	P DME	
294	PHOENIX /AZ	PHX	EXS AIR CARR	33 26 07 N	112 00 43 W	26L	YES	FULL CAP BAZ	P DME	
295	PHOENIX /AZ	PHX	EXS AIR CARR	33 26 07 N	112 00 43 W	15	NO	MINIMUM CAP	P DME	
297	PHOENIX /AZ	DVT	EXS GENERAL	33 41 13 N	112 04 57 W	7R	YES	MINIMUM CAP	P DME	
298	PHOENIX /AZ	DVT	EXS GENERAL	33 41 13 N	112 04 57 W	14	NO	MINIMUM CAP	P DME	
299	PRESCOTT /AZ	PRC	EXS AIR CARR	34 39 05 N	112 25 15 W	3	YES	MINIMUM CAP	P DME	
301	SCOTTSDALE/AZ	SOL	EXS GENERAL	33 37 10 N	111 54 53 W	3	YES	MINIMUM CAP	P DME	

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*** AIRPORT ENVIRONMENT ***												
SYSTEM IDN	LOCATION CITY/STATE	FAC CALL	AIRPORT TYPE	FAC LATITUDE	FAC LONGITUDE	RUN WAY	EXIST RWY	MLS SERVICE	DME EQUIPMENT	LINK NUM		
305	TUCSON /AZ	RYN	EXS GENERAL	32 08 29 N	111 10 00 W	6L	Y-S	MINIMUM CAP	P DME			
311	TUNA /AZ	TUN	EXS AIR CARR	32 3 24 N	114 36 18 W	3L	YES	FULL CAP	P DME			
312	TUNA /AZ	TUN	EXS AIR CARR	32 39 24 N	114 36 14 W	21R	YES	FULL CAP	P DME			
313	TUNA /AZ	TUN	EXS AIR CARR	32 39 24 N	114 36 18 W	8	YES	MINIMUM CAP	P DME			
314	BEALE AFB /CA	BAB	EXS MILITARY	39 08 00 N	121 26 00 W	14	YES	FULL CAP BAZ	P DME			
315	CASTLE AFB/CA	RLR	EXS MILITARY	37 23 00 N	120 34 00 W	30	YES	FULL CAP BAZ	P DME	20		
316	CASTLE AFB/CA	RLR	EXS MILITARY	37 23 00 N	120 34 00 W	12	YES	FULL CAP BAZ	P DME	20		
317	TRAVIS AFB/CA	SUU	EXS MILITARY	38 16 00 N	121 56 00 W	21	YES	FULL CAP BAZ	P DME	21		
318	TRAVIS AFB/CA	SUU	EXS MILITARY	38 16 00 N	121 56 00 W	3	YES	FULL CAP BAZ	P DME	21		
319	VANDENBURG/CA	VBG	EXS MILITARY	34 43 00 N	120 34 00 W	30	YES	FULL CAP BAZ	P DME			
320	VANDENBURG/CA	VBG	EXS MILITARY	34 54 00 N	117 52 30 W	22	YES	FULL CAP BAZ	P DME			
321	MARCH AFB /CA	MRX	EXS MILITARY	33 53 00 N	117 16 00 W	31	YES	FULL CAP BAZ	P DME			
322	MC CLELLAN/CA	MCC	EXS MILITARY	38 40 00 N	121 24 00 W	16	YES	FULL CAP BAZ	P DME	22		
323	MC CLELLAN/CA	MCC	EXS MILITARY	38 40 00 N	121 24 00 W	34	YES	FULL CAP BAZ	P DME	22		
324	MATHER AFB/CA	MHR	EXS MILITARY	38 34 00 N	121 18 00 W	22	YES	FULL CAP BAZ	P DME	23		
325	MATHER AFB/CA	MHR	EXS MILITARY	38 34 00 N	121 18 00 W	4	YES	FULL CAP BAZ	P DME	23		
326	NORTON AFB/CA	SBD	EXS MILITARY	34 06 00 N	117 14 00 W	6	YES	FULL CAP BAZ	P DME			
327	HAMILTON /CA	SRE	EXS MILITARY	38 04 00 N	122 30 00 W	30	YES	FULL CAP BAZ	P DME			
328	EL TORO /CA	NZJ	EXS MILITARY	33 40 00 N	117 44 00 W	35R	YES	FULL CAP BAZ	P DME			
330	WILLIAMS /AZ	CHD	EXS MILITARY	33 18 00 N	111 40 00 W	30R	YES	FULL CAP BAZ	P DME			
332	CHINA LK /CA	NIA	EXS MILITARY	35 41 00 N	117 41 00 W	32	YES	FULL CAP BAZ	P DME			
333	CROWSLAND /CA	NRC	EXS MILITARY	37 24 00 N	121 06 00 W	35	YES	FULL CAP BAZ	P DME			
334	EL CENTRO /CA	NJK	EXS MILITARY	32 49 00 N	115 40 00 W	30R	YES	FULL CAP BAZ	P DME			
335	FRITZSCHE /CA	OAR	EXS MILITARY	36 41 00 N	121 46 00 W	29	YES	FULL CAP BAZ	P DME			
336	IMPERIAL B/CA	VCV	EXS MILITARY	34 35 00 N	117 23 00 W	16	YES	FULL CAP BAZ	P DME			
337	GEORGE AFB/CA	NRS	EXS MILITARY	33 34 00 N	117 07 00 W	9	YES	FULL CAP BAZ	P DME			
338	LEMOORE /CA	NLC	EXS MILITARY	36 20 00 N	119 57 00 W	32L	YES	FULL CAP BAZ	P DME			
340	MUFFETT FJ/CA	NUO	EXS MILITARY	37 25 00 N	122 03 00 W	32L	YES	FULL CAP BAZ	P DME			
341	NORTH ISLN/CA	NZY	EXS MILITARY	34 07 00 N	119 57 00 W	3	YES	FULL CAP BAZ	P DME			
342	PT MUGU /CA	MTD	EXS MILITARY	33 01 00 N	118 35 00 W	23	YES	FULL CAP BAZ	P DME			
343	SAN CLEMENTE/CA	NUC	EXS MILITARY	33 14 00 N	119 28 00 W	30	YES	FULL CAP BAZ	P DME			
344	SAN NICOLAS/CA	NSI	EXS MILITARY	33 42 00 N	117 50 00 W	24	YES	FULL CAP BAZ	P DME			
345	SANTA ANA /CA	NIK	EXS MILITARY	33 33 00 N	112 22 00 W	3R	YES	FULL CAP BAZ	P DME	24		
346	LUKE AFB /AZ	LUF	EXS MILITARY	33 33 00 N	112 22 00 W	21L	YES	FULL CAP BAZ	P DME	24		
347	LUKE AFB /AZ	LUF	EXS MILITARY	39 25 00 N	118 42 00 W	31	YES	FULL CAP BAZ	P DME			
348	FALCON /NV	NFL	EXS MILITARY	36 14 00 N	115 02 00 W	3R	YES	FULL CAP BAZ	P DME	25		
349	NELLIS AFB/NV	LSV	EXS MILITARY	36 14 00 N	115 02 00 W	21L	YES	FULL CAP BAZ	P DME	25		
350	NELLIS AFB/NV	LSV	EXS MILITARY	34 37 46 N	118 05 01 W	25	YES	FULL CAP BAZ	P DME			
352	PALMDALE /CA	PHD	EXS AIR CARR	34 37 46 N	118 05 01 W	7	YES	FULL CAP BAZ	P DME			
353	PALMDALE /CA	PHD	EXS AIR CARR	34 37 46 N	118 05 01 W	22	YES	FULL CAP BAZ	P DME			
354	PALMDALE /CA	PHD	EXS AIR CARR	34 37 46 N	118 05 01 W	4	YES	FULL CAP BAZ	P DME			
355	PALMDALE /CA	PHD	EXS AIR CARR	34 37 46 N	118 05 01 W	6	YES	FULL CAP BAZ	P DME			
356	STGEORGE /UT	SGU	EXS GENERAL	33 05 20 N	113 35 45 W	7	YES	MINIMUM CAP	P DME			
357	BURRLEGGSPR/CA	LJR	EXS GENERAL	33 15 35 N	116 19 26 W	7	YES	MINIMUM CAP	P DME			

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\*\*\* ENROUTE ENVIRONMENT \*\*\*

SYSTEM ID	LOCATION CITY STATE	EQUIP LATITUDE	EQUIP LONGITUDE	EQUIPMENT TYPE	SERVICE VOLUME	CALL LETTERS	LINK NUM
80061	GEORGEAB	CA 34 35 41 N	117 23 21 W	TACAN	LOW	VCV	
80062	BEALE	CA 39 08 06 N	121 26 23 W	TACAN	LOW	BAB	
80063	IMP BGM	CA 32 33 51 N	117 06 32 W	TACAN	LOW	NRS	
80064	MIRAMAR	CA 32 52 11 N	117 09 14 W	TACAN	LOW	NKX	
80065	EL TORO	CA 33 46 28 N	117 43 34 W	TACAN	LOW	NZJ	
80066	CRMS LND	CA 37 24 25 N	121 06 44 W	TACAN	LOW	NRZ	
80067	SHNICLIS	CA 33 14 06 N	119 27 27 W	TACAN	LOW	NSI	
80068	PT MUGU	CA 34 07 24 N	119 07 16 W	TACAN	LOW	NTD	
80069	SEAL BGM	CA 33 43 50 N	118 05 10 W	TACAN	TERMINAL		
80070	CHWSLNDG	CA 37 24 40 N	121 06 33 W	TACAN	LOW		
80071	CHINA LN	CA 35 41 17 N	117 41 23 W	TACAN	LOW	NTD	
80072	CPNMULTN	CA 33 18 04 N	117 21 01 W	TACAN	TERMINAL	OCS	
80073	VANDENBG	CA 34 43 57 N	120 34 55 W	TACAN	LOW	V86	
80074	SNCLEMT	CA 33 01 37 N	118 34 43 W	TACAN	LOW	MUC	
80075	HAMILTON	CA 38 03 35 N	122 30 14 W	TACAN	LOW	SRF	
80076	LUKE	AZ 33 32 41 N	112 22 52 W	TACAN	LOW	LUF	
80077	MARCHAFB	CA 33 54 25 N	117 16 26 W	TACAN	LOW	RIV	
80078	ALAMEDA	CA 37 47 31 N	122 19 45 W	TACAN	LOW	NGZ	
80079	MATHERAB	CA 38 33 04 N	121 17 44 W	TACAN	LOW	MHR	
80080	FALLON	NE 39 24 59 N	118 42 10 W	TACAN	HIGH	NFL	
80081	TUNA	AZ 32 38 48 N	114 36 45 W	TACAN	LOW	NYL	
80082	IRAVISAB	CA 38 14 44 N	121 56 38 W	TACAN	LOW	SUU	
80083	MTWISLO	CA 32 41 53 N	117 14 05 W	TACAN	LOW	NZY	
80084	SNCLEMT	CA 33 01 37 N	118 34 43 W	TACAN	LOW	MUC	
80085	HOFFFELD	CA 37 25 57 N	122 03 23 W	TACAN	LOW	MUB	
80086	FLGSTAFF	AZ 34 36 00 N	111 40 24 W	VOR 1-A	LOW	FLG	
80087	VENTURA	CA 34 06 54 N	119 02 55 W	VOR 1-A	LOW	VTU	
80088	LAK HUGUE	CA 34 40 59 N	118 34 34 W	VOR 1-A	LOW	LMS	
80089	GLOBE	AZ 33 22 38 N	110 43 23 W	VOR 1-A	LOW	G08	
80090	CDR HUN	UT 37 47 15 N	113 04 01 W	VOR 1-A	LOW	CDC	
80091	SANT AN	CA 33 40 01 N	117 51 43 W	VOR 1-A	TERMINAL	SNA	
80092	KINGMAN	AZ 35 15 38 N	113 56 00 W	VOR 1-A	LOW	IGM	
80093	SANT MAR	CA 34 57 09 N	120 31 14 W	VOR 1-A	TERMINAL	SMK	
80094	PORTVIL	CA 35 54 47 N	119 01 12 W	VOR 1-A	LOW	PTV	
80095	VISALIA	CA 36 22 03 N	119 28 52 W	VOR 1-A	TERMINAL	VIS	
80096	SNT CALA	CA 33 22 30 N	118 25 06 W	VOR 1-A	LOW	SXC	
80097	SANT ROS	CA 38 30 30 N	122 48 34 W	VOR 1-A	LOW	STS	
80098	WISHOP	CA 37 22 37 N	118 21 56 W	VOR 1-A	LOW	BIM	
80099	SNT GEOR	UT 37 05 17 N	113 35 30 W	VOR 1-A	TERMINAL	OZN	
80100	PRIEST	CA 36 08 26 N	120 39 50 W	VOR 1-A	LOW	ROM	
80101	HUCKEYE	CA 33 27 12 N	112 49 26 W	VOR 1-A	LOW	BKK	
80102	ELY	NV 39 17 54 N	114 50 51 W	VOR 1-A	LOW	ELY	
80103	SNT MONC	CA 34 00 37 N	118 27 21 W	VOR 1-A	LOW	SMO	
80104	MARYSVIL	CA 39 05 56 N	121 34 19 W	VOR 1-A	TERMINAL	MYV	
80105	SNT MONC	CA 34 00 37 N	118 27 21 W	VOR 1-A	LOW	SMO	
80106	RIVERSIO	CA 33 57 07 N	117 26 54 W	VOR 1-A	LOW	RAL	
80107	PONOMA	CA 34 04 42 N	117 47 10 W	VOR 1-A	LOW	POH	
80108	VANDENBE	CA 34 42 56 N	120 33 30 W	VOR 1-A	LOW	V86	
80109	PEACH SP	AZ 35 37 29 N	113 32 37 W	VOR 1-A	HIGH	PGS	
80110	MILFORD	UT 38 21 37 N	113 00 45 W	VOR 1-A	HIGH	MLF	

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... ENROUTE ENVIRONMENT ...							
SYSTEM ID	LOCATION CITY STATE	EQUIP LATITUDE	EQUIP LONGITUDE	EQUIPMENT TYPE	SERVICE VOLUME	CALL LETTERS	LINK NUM
900053	NAPA CO	CA 38 10 46 N	122 22 14 W	VOR 1-A	LOW	APC	
900054	ONTARIO	CA 33 55 06 N	117 31 44 W	VOR 1-B	HIGH	ONT	
900059	SAN LUIS	CA 35 15 08 N	120 45 31 W	VO 1-A	LOW	SBP	
900060	FILLMORE	CA 34 21 24 N	119 52 49 W	VOR 1-A	LOW	FIM	
900061	WINSLOW	AZ 35 03 42 N	110 47 40 W	VOR 1-A	HIGH	INW	
900062	LOS BANO	CA 36 42 56 N	120 46 40 W	VOR 1-A	LOW	PXM	
900063	HECTOR	CA 39 47 49 N	116 27 43 W	VOR 1-A	HIGH	HEC	
900064	BRYCE CY	UT 37 41 21 N	112 18 11 W	VOR 1-A	HIGH	BCE	
900065	FRESNA T	CA 36 53 12 N	119 48 11 W	VOR 1-A	HIGH	FAT	
900066	GRND CVN	AZ 35 57 37 N	112 08 43 W	VOR 1-A	LOW	GCN	
900067	VAN NUYS	CA 34 13 24 N	118 29 27 W	VOR 1-B	LOW	VNY	
900068	UAGBETT	CA 34 57 45 N	116 34 38 W	VOR 1-A	HIGH	DAG	
900069	LAK TAP	CA 39 10 50 N	120 16 07 W	VOR 1-A	LOW	LTA	
900070	CHANDLER	AZ 33 18 11 N	111 39 03 W	VOR 1-A	LOW	CHO	
900071	MARCH AF	CA 33 46 31 N	117 11 17 W	VOR 1-A	TERMINAL	RIV	
900072	TUBA CITY	AZ 36 07 17 N	111 16 08 W	VOR 1-A	HIGH	TBC	
900073	L A INTL	CA 33 55 59 N	118 25 52 W	VOR 1-A	HIGH	LAX	
900075	PT REYES	CA 38 04 47 N	122 52 08 W	VO 1-B	LOW	PYE	
900076	WOODSIDE	CA 37 23 33 N	122 16 49 W	VOR 1-B	LOW	OSI	
900077	JULIAN	CA 33 08 26 N	116 35 06 W	VOR 1-A	LOW	JLI	
900078	BIG SUR	CA 36 10 53 N	121 38 28 W	VOR 1-A	LOW	BSR	
900080	PSCOT RD	AZ 34 42 09 N	112 28 46 W	VOR 1-A	HIGH	PRC	
900081	HAZEN	NV 39 30 59 N	118 59 48 W	VOR 1-A	LOW	HZN	
900082	SN JOS M	CA 37 21 53 N	121 55 45 W	VOR 1-A	LOW	SJC	
900083	ININ PLM	CA 34 06 44 N	115 46 09 W	VOR 1-A	LOW	TMP	
900085	MERCED	CA 37 13 10 N	120 23 57 W	VOR 1-A	LOW	MCE	
900087	MORRIS MS	NV 36 46 16 N	114 16 36 W	VOR 1-A	LOW	MMW	
900088	PASO R M	CA 35 40 21 N	120 37 34 W	VOR 1-A	LOW	PRB	
900089	GOFFS	CA 35 07 52 N	115 10 32 W	VOR 1-A	LOW	GFS	
900090	WILLIAMS	CA 39 04 16 N	122 01 34 W	VOR 1-A	LOW	ILA	
900091	PALMDALE	CA 34 37 53 N	118 03 47 W	VOR 1-A	HIGH	PMO	
900093	MOSTI-C-C	CA 37 37 39 N	120 57 24 W	VOR 1-A	HIGH	MOD	
900094	BEATTY	NV 36 48 02 N	116 44 48 W	VOR 1-A	HIGH	BTY	
900095	CAS GRND	AZ 32 53 09 N	111 54 29 W	VOR 1-A	HIGH	CZG	
900096	LINDED	CA 38 04 29 N	121 00 10 W	VOR 1-A	HIGH	LTN	
900097	SMT BA M	CA 39 30 35 N	119 46 12 W	VOR 1-A	HIGH	SBA	
900098	MINA	NV 38 33 55 N	118 01 55 W	VOR 1-A	HIGH	MVA	
900099	SACRAM X	CA 38 26 31 N	121 33 02 W	VOR 1-A	HIGH	SAC	
900100	NEEDLE M	CA 34 45 58 N	114 28 24 W	VOR 1-A	HIGH	EED	
900101	OCEANSID	CA 33 14 26 N	117 25 01 W	VOR 1-A	HIGH	OCN	
900103	BAKERFLO	CA 35 29 05 N	119 05 47 W	VOR 1-A	HIGH	BFL	
900104	PLM SPR	CA 33 52 12 N	116 25 44 W	VOR 1-A	LOW	PSP	
900105	FRIANT	CA 37 06 16 N	119 35 40 W	VOR 1-A	LOW	FRA	
900106	PHX S HB	AZ 33 25 53 N	111 53 17 W	VOR 1-B	HIGH	PHX	
900107	SCAL BCH	CA 33 47 00 N	118 03 14 W	VOR 1-A	LOW	SLI	
900110	S F INTL	CA 37 36 50 N	122 21 23 W	VOR 1-A	LOW	SFO	
900112	S F INTL	CA 37 37 10 N	122 22 22 W	VOR 1-A	HIGH	SFO	
900113	CAMARILLO	CA 34 12 45 N	119 05 36 W	VOR 1-A	LOW	CMA	
900114	IMPERIAL	CA 32 44 55 N	115 33 28 W	VOR 1-A	HIGH	IPL	
900116	STRIN ME	CA 37 50 01 N	121 10 13 W	VOR 1-A	HIGH	SCK	

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*** ENROUTE ENVIRONMENT ***									
SYSTEM DN	LOCATION CITY STATE	EQUIP LATITUDE	EQUIP LONGITUDE	EQUIP TYPE	SERVICE VOLUME	CALL LETTERS	LINK RUN		
90117	GORMAN	CA 34 48 15 N	118 51 38 W	VOR 1-A	LOW	GMN			
90119	THERMAL	CA 33 37 4 N	116 09 34 W	VOR 1-A	HIGH	TRM			
90120	SAUSALIT	CA 37 51 19 N	122 31 18 W	VOR 1-A	LOW	SAU			
90121	WILSON CK	NV 36 15 01 N	114 23 36 W	VOR 1-A	HIGH	ILC			
90122	EDW AFB	CA 34 58 57 N	117 43 54 W	VOR 1-A	LOW	EDW			
90123	TRAVIS A	CA 38 20 40 N	121 48 35 W	VOR 1-A	LOW	SUN			
90124	LOVELOCK	NV 40 04 00 N	118 33 36 W	VOR 1-A	LOW	LCL			
90125	GAVIOTA	CA 34 31 5 N	120 05 24 W	VOR 1-A	LOW	GVO			
90127	GILA BEN	AZ 32 57 22 N	112 40 25 W	VOR 1-A	HIGH	GBN			
90128	HOLCK CI	NV 35 59 45 N	114 51 46 W	VOR 1-A	HIGH	BLD			
90129	YURA	AZ 32 46 05 N	114 36 08 W	VOR 1-A	HIGH	YUM			
90131	OAKLAND	CA 37 43 34 N	122 13 21 W	VOR 1-A	HIGH	OAK			
90132	LAS VEGA	NV 36 04 47 N	115 09 32 W	VOR 1-A	HIGH	LAS			
90133	CONCORD	CA 38 02 42 N	122 02 39 W	VOR 1-A	TERMINAL	CCR			
90135	AVENAL	CA 35 38 45 N	119 58 39 W	VOR 1-A	HIGH	AVE			
90136	TUNOPAN	NV 38 01 51 N	117 01 57 W	VOR 1-A	LOW	TPH			
90137	EL TORO	CA 33 40 03 N	117 43 30 W	VOR 1-A	LOW	NZJ			
90138	SALIN RU	CA 36 39 50 N	121 36 06 W	VOR 1-A	HIGH	SNS			
90139	BLAYNE	CA 33 35 46 N	114 45 37 W	VOR 1-A	HIGH	BLM			
90140	FELLOWS	CA 35 5 35 N	119 51 53 W	VOR 1-A	LOW	FLW			
90141	PAGE	AZ 36 55 41 N	111 27 00 W	VOR 1-A	TERMINAL	PGA			
90142	COALDALE	NV 38 00 1 N	117 46 10 W	VOR 1-A	HIGH	OAL			
90143	MISH BAY	CA 32 46 56 N	117 13 28 W	VOR 1-A	HIGH	MZB			
90145	PARKER	CA 39 6 07 N	114 40 52 W	VOR 1-A	HIGH	PRE			
90146	REMO INT	NV 39 31 53 N	119 39 18 W	VOR 1-A	HIGH	RNO			
90147	REALL	CA 39 17 48 N	121 30 32 W	VOR 1-A	LOW	RAB			
90149	MCCELLIN	CA 38 40 03 N	121 24 12 W	VOR 1-A	LOW	MCC			
90150	VISALIA	CA 36 22 03 N	119 28 52 W	VOR 1-A	TERMINAL	VIS			
90151	SANTAMAR	CA 34 57 09 N	120 31 14 W	VOR 1-A	TERMINAL	SNX			
90152	FT OHIO	CA 36 41 00 N	121 46 00 W	VOR 1-A	LOW	FTO			
90153	SANTAROS	CA 38 30 30 N	122 48 34 W	VOR 1-A	LOW	STS			
90154	LEMOORE	CA 36 32 39 N	119 57 55 W	VOR 1-A	LOW	MLC			
90155	PLACERVILLE	CA 38 43 27 N	120 44 57 W	VOR 1-A	LOW	PLC			

NORMAL EXIT. CPU TIME: 755 MILLISECONDS. 5512 7 MILLISECONDS ESTIMATED DEDICATED TIME.  
UNIVAC ALIB LEVEL-7401-ECAC RL10-LEVEL-7

RED FAA-MLSELTS/FAA-SUMELM  
ED 298 07/10/81 11:09 SUMELM51F

SPEC1 WRITING NOT PERMITTED KEY NEEDED

EDIT

\*\*\*\*\* EXTENDED ERROR ANALYSIS \*\*\*\*\*  
CONTINGENCY TYPE 012 ERROR TYPE 1-ERROR CODE 020 AT PROGRAM ADDRESS 0121103.  
TRIED TO WRITE FILE WITHOUT WRITE PERMISSION.

\*\*\*\*\* ANALYSIS OF I/O PACKET FOUND IN ERROR \*\*\*\*\*

091192 222130122131 FILENAME: \*MLSELTS\*.  
091193 3005050505

TABLE A-2  
D/U PROTECTION MATRIX,  
IN dB<sup>a</sup>

L-Band	TACAN				DME (100 w)				PDME <sup>b</sup>			
	TACAN	DME	TACAN	PDME <sup>b</sup>	TACAN	DME	TACAN	PDME <sup>b</sup>	TACAN	DME	TACAN	PDME <sup>b</sup>
Undesired Source												
Desired Source												
Cofrequency Co-aperture	+8	+8	+8	+8	+8	+8	+8	+8	+8	+8	+8	+8
Cofrequency Out-of-aperture	--	--	--	-50	--	--	--	-50	+8	+3	--	-50
First adjacent frequency Co-aperture	-42	-46	-60	-60	-29	-29	-25	-60	-25	-25	-25	-60
First adjacent frequency Out-of-aperture	--	--	--	-75	--	--	--	-75	-34	-34	-34	-75
Second adjacent frequency Co-aperture	-50	-54	-75	-75	-38	-38	-34	-75	-34	-34	-34	-75
Second adjacent frequency Out-of-aperture	--	--	--	-75	--	--	--	-75	-34	-34	-34	-75
C-Band												

The angle guidance protection criteria (D/U) is +24, -21, and -23 dB for cochannel, 1st and 2nd adjacent channels, respectively. The ratio is based on a comparison of preamble ERP from the desired and undesired sources.

<sup>a</sup>Reference 3.

<sup>b</sup>If DME/P systems are assigned on conventional X or Y channels, the required protection criteria is the same as for conventional TACAN/DME equipment. This will afford the necessary protection for existing avionics that may use those systems.

APPENDIX B  
FULL CAPABILITY VS. MINIMUM CAPABILITY DISTINCTION

This appendix is a discussion of the rationale used in the generation of the ground portion of the MLS STIM ('81). In particular, it addresses the selection of airport and en route facilities that are included in the STLM ('81) and describes the logic used to categorize the airport facilities as either "full capability" or "minimum capability."

The STLM ('81) is a circular region within a larger MLS environmental model that had been constructed for the FAA in 1979 to represent the potential future MLS scenario in the Southwest U.S. STIM ('81) includes airport and en route facilities within 365 nmi of Los Angeles and covers portions of four states -- California, Nevada, Utah, and Arizona. Basically, the STLM ('81) includes all en route facilities presently operating in the region with no growth projected. Each existing airport facility was included in the environment as requiring future MLS service if either criterion A or B, and either criterion C or D, as noted below, were true.

- A. Presently has an FAA tower.
- B. Candidate for an FAA tower.
- C. Currently receiving or forecast to receive certified route air carrier or scheduled passenger commuter service.
- D. Is a general aviation airport that will exceed 60,000 itinerant or 100,000 total operations annually.

Forecasts were drawn from the U.S. Terminal Area Forecasts, Fiscal Years 1979-1990.<sup>5</sup>

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<sup>5</sup>Federal Aviation Administration, Forecasting Branch, U.S. Terminal Area Forecasts, Fiscal Years 1979-1990, Washington, DC, 1979.

A further distinction was made within the group of airport facilities in order to separate those with an expected high volume of traffic in large metropolitan areas from those with less expected traffic in smaller communities. The two categories of airport facilities were called "full capability" and "minimum capability," respectively. Figure B-1 is a flow diagram that represents the method used in making this further distinction.

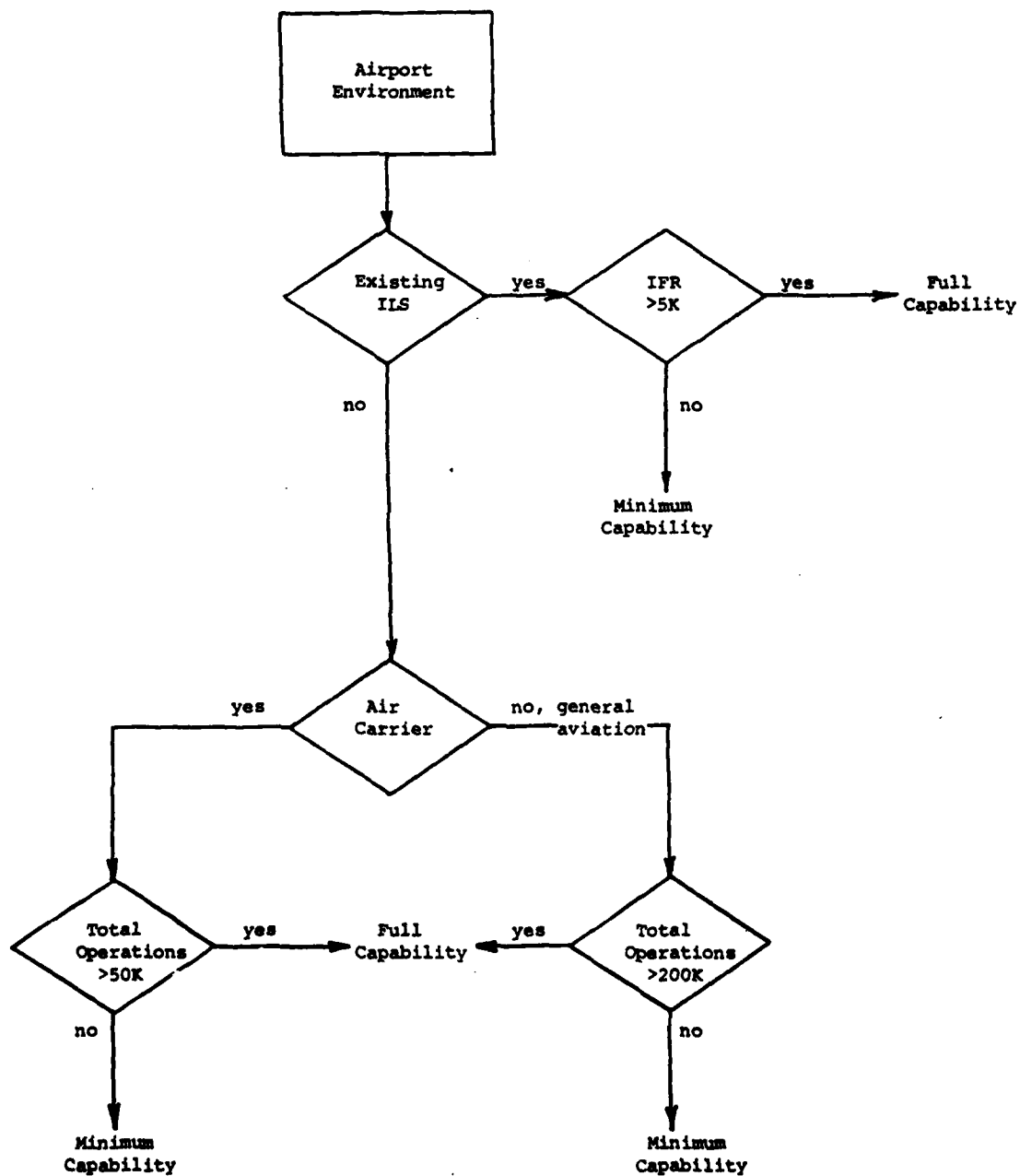


Figure B-1. Full capability/minimum capability decision tree.

APPENDIX C  
PROPOSED MLS CHANNEL PLANS

Many channelization ideas have been proposed as methods to facilitate the eventual implementation of the MLS. One of the main objectives of all of these ideas has been to maintain L-Band interoperability with conventional TACAN/DME equipments at least during the early phases of the transition to MLS. Other objectives have focused on attempting to time-multiplex a large portion of the MLS DME/P channels within the frequency range presently set aside for ILS-DME. Most channel plans were built presupposing the ability of present and future DME(N) receivers to reject, to a certain degree, undesired signals that use the same frequency but different pulse-pair spacings from the conventional 12- $\mu$ s spacing in use. Other channel plans were designed assuming that a large number of the new MLS DME/P channels could use frequencies currently set aside solely for en route systems but that were largely unused.

Although many channelization concepts have been discussed for MLS over the last 10 years, only three complete MLS DME/P channel plans have been presented and discussed at AWOP meetings in the last 3 years, and another partial plan was submitted in 1981.

SEATTLE CHANNEL PLAN

During the AWOP Working Group M/3 meeting in Seattle, Washington, in 1979, the Federal Republic of Germany submitted a channel plan to be considered for use with the MLS. It was the first formal submission to AWOP of a channel plan that defined channels for DME/P. This channel plan contains 200 DME/P channels in L-Band as follows.

- |    |   |
|----|---|
| 40 | Channels shared with ILS-DME (18-56 even, X and Y)  |
| 80 | Channels by multiplexing additional pulse-pair spacings T, U, V, and W on existing 20 ILS-DME X channels (18-56 even) |

- 80 Channels by multiplexing additional pulse-pair spacings T, U, V, and W on existing low-band en route X channels (19-59 odd)

TABLE C-1 is a listing of the frequencies and related channel numbers contained in "the Seattle Plan."

#### O8C CHANNEL PLAN

An MLS channel plan had been developed by the U.S. and is described in a draft MLS signal format specification<sup>6</sup> that has been distributed to other AWOP members. Although this plan has not been formally submitted to AWOP for consideration by the U.S., the subgroup on Channel Plans and Traffic Loading considers it a viable plan to be considered with the others. Like the Seattle Plan, the "O8C Plan" contains 200 DME/P channels in L-Band but, in general, depends less on pulse-pair multiplexing and more on the ability to redefine existing en route channels for MLS use. A summary of the O8C Channel Plan is as follows.

- 40 Channels shared with ILS-DME (18-56 even, X and Y)
- 40 Channels created by multiplexing an additional pulse-pair spacing on the existing 20 ILS-DME X channels (18Z-56Z, even) and also on the existing en route X channels (19Z-57Z, odd)
- 47 Channels created by redefining some high-band en route Y channels for MLS use (78Y-124Y)
- 14 Channels created by redefining some low-band en route Y channels for MLS use (19Y-45Y)

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<sup>6</sup>Department of Transportation/Federal Aviation Administration, Microwave Landing System (MLS) Signal Format Specification for the Time Reference Scanning Beam, FAA-ER-700-08C, Washington, DC, May 1979.

TABLE C-1  
THE SEATTLE CHANNEL PLAN  
(Page 1 of 4)

CHANNEL NM	C-BAND (MHZ)	POPE L-BAND (MHZ)	CONVENTIONAL L-BAND (MHZ)	VCR/ILS (MHZ)	GLIDESLOPE
18X	5021.00	979.00	979.00	108.10	334.70
187	5021.30	979.00	.00	.00	.00
18L	5021.60	979.00	.00	.00	.00
18V	5021.90	979.00	.00	.00	.00
18A	5022.20	979.00	.00	.00	.00
18Y	5022.50	1105.00	1105.00	108.15	334.55
191	5022.80	980.00	.00	.00	.00
19U	5023.10	980.00	.00	.00	.00
19A	5023.40	980.00	.00	.00	.00
19W	5023.70	980.00	.00	.00	.00
20X	5024.00	981.00	981.00	108.20	334.10
201	5024.30	981.00	.00	.00	.00
20L	5024.60	981.00	.00	.00	.00
20V	5024.90	981.00	.00	.00	.00
20A	5025.20	981.00	.00	.00	.00
20Y	5025.50	1107.00	1107.00	108.35	334.95
211	5025.80	982.00	.00	.00	.00
21U	5026.10	982.00	.00	.00	.00
21V	5026.40	982.00	.00	.00	.00
21A	5026.70	982.00	.00	.00	.00
22X	5027.00	983.00	.00	108.58	329.90
221	5027.30	983.00	.00	.00	.00
22L	5027.60	983.00	.00	.00	.00
22V	5027.90	983.00	.00	.00	.00
22A	5028.20	983.00	.00	.00	.00
22Y	5028.50	1109.00	1109.00	108.55	329.75
231	5028.80	984.00	.00	.00	.00
23U	5029.10	984.00	.00	.00	.00
23V	5029.40	984.00	.00	.00	.00
23A	5029.70	984.00	.00	.00	.00
24X	5040.00	985.00	.00	108.70	330.50
241	5040.30	985.00	.00	.00	.00
24U	5040.60	985.00	.00	.00	.00
24V	5040.90	985.00	.00	.00	.00
24A	5041.20	985.00	.00	.00	.00
24Y	5041.50	1111.00	1111.00	108.75	330.35
251	5041.80	986.00	.00	.00	.00
25U	5042.10	986.00	.00	.00	.00
25V	5042.40	986.00	.00	.00	.00
25A	5042.70	986.00	.00	.00	.00
26X	5043.00	987.00	.00	108.90	329.30
261	5043.30	987.00	.00	.00	.00
26L	5043.60	987.00	.00	.00	.00
26V	5043.90	987.00	.00	.00	.00
26A	5044.20	987.00	.00	.00	.00
26Y	5044.50	1113.00	1113.00	108.95	329.15
271	5044.80	988.00	.00	.00	.00
27U	5045.10	988.00	.00	.00	.00
27V	5045.40	988.00	.00	.00	.00
27A	5045.70	988.00	.00	.00	.00
28X	5046.00	989.00	989.00	109.10	331.40
281	5046.30	989.00	.00	.00	.00
28U	5046.60	989.00	.00	.00	.00
28V	5046.90	989.00	.00	.00	.00
28A	5047.20	989.00	.00	.00	.00

TABLE C-1  
(Page 2 of 4)

28Y	5047.50	1115.00	1115.00	109.15	331.25
29I	5047.60	990.00	.00	.00	.00
29U	5048.10	950.00	.00	.00	.00
29V	5048.40	950.00	.00	.00	.00
29W	5048.70	950.00	.00	.00	.00
30X	5049.00	991.00	991.00	109.30	332.00
30Y	5049.30	951.00	.00	.00	.00
30Z	5049.60	991.00	.00	.00	.00
30V	5049.90	951.00	.00	.00	.00
30W	5050.20	991.00	.00	.00	.00
30Y	5050.50	1117.00	1117.00	109.35	331.85
31I	5050.80	952.00	.00	.00	.00
31L	5051.10	952.00	.00	.00	.00
31V	5051.40	992.00	.00	.00	.00
31W	5051.70	952.00	.00	.00	.00
32X	5052.00	993.00	993.00	109.50	332.60
32Y	5052.30	953.00	.00	.00	.00
32Z	5052.60	952.00	.00	.00	.00
32V	5052.90	953.00	.00	.00	.00
32W	5053.20	953.00	.00	.00	.00
32Y	5053.50	1119.00	1119.00	109.55	332.45
33I	5053.80	994.00	.00	.00	.00
33U	5054.10	954.00	.00	.00	.00
33V	5054.40	994.00	.00	.00	.00
33W	5054.70	954.00	.00	.00	.00
34X	5055.00	995.00	995.00	109.70	333.20
34I	5055.30	955.00	.00	.00	.00
34L	5055.60	995.00	.00	.00	.00
34V	5055.90	955.00	.00	.00	.00
34W	5056.20	995.00	.00	.00	.00
34Y	5056.50	1121.00	1121.00	109.75	333.05
35I	5056.80	956.00	.00	.00	.00
35U	5057.10	956.00	.00	.00	.00
35V	5057.40	996.00	.00	.00	.00
35W	5057.70	956.00	.00	.00	.00
36X	5058.00	997.00	997.00	109.70	332.80
36I	5058.30	957.00	.00	.00	.00
36L	5058.60	997.00	.00	.00	.00
36V	5058.90	957.00	.00	.00	.00
36W	5059.20	997.00	.00	.00	.00
36Y	5059.50	1123.00	1123.00	109.95	332.65
37I	5059.80	998.00	.00	.00	.00
37U	5060.10	958.00	.00	.00	.00
37V	5060.40	998.00	.00	.00	.00
37W	5060.70	958.00	.00	.00	.00
38X	5061.00	999.00	999.00	110.10	334.40
38I	5061.30	999.00	.00	.00	.00
38L	5061.60	959.00	.00	.00	.00
38V	5061.90	999.00	.00	.00	.00
38W	5062.20	959.00	.00	.00	.00
38Y	5062.50	1125.00	1125.00	110.15	334.25
39I	5062.80	1000.00	.00	.00	.00
39L	5063.10	1000.00	.00	.00	.00
39V	5063.40	1000.00	.00	.00	.00
39W	5063.70	1000.00	.00	.00	.00
40X	5064.00	1001.00	1001.00	110.30	335.00
40I	5064.30	1001.00	.00	.00	.00
40U	5064.60	1001.00	.00	.00	.00
40V	5064.90	1001.00	.00	.00	.00

TABLE C-1  
(Page 3 of 4)

40W	5065.20	1001.00	.00	.00	.00
40Y	5065.50	1127.00	1127.00	110.25	334.05
411	5065.80	1002.00	.00	.00	.00
41U	5066.10	1002.00	.00	.00	.00
41V	5066.40	1002.00	.00	.00	.00
41W	5066.70	1002.00	.00	.00	.00
42X	5067.00	1003.00	1003.00	110.50	329.60
421	5067.30	1003.00	.00	.00	.00
42L	5067.60	1003.00	.00	.00	.00
42V	5067.90	1003.00	.00	.00	.00
42W	5068.20	1003.00	.00	.00	.00
42Y	5068.50	1129.00	1129.00	110.55	329.45
431	5068.80	1004.00	.00	.00	.00
43L	5069.10	1004.00	.00	.00	.00
43V	5069.40	1004.00	.00	.00	.00
43W	5069.70	1004.00	.00	.00	.00
44X	5070.00	1005.00	1005.00	110.70	330.20
441	5070.30	1005.00	.00	.00	.00
44U	5070.60	1005.00	.00	.00	.00
44V	5070.90	1005.00	.00	.00	.00
44W	5071.20	1005.00	.00	.00	.00
44Y	5071.50	1121.00	1121.00	110.75	330.05
451	5071.80	1005.00	.00	.00	.00
45L	5072.10	1006.00	.00	.00	.00
45V	5072.40	1006.00	.00	.00	.00
45W	5072.70	1006.00	.00	.00	.00
46X	5073.00	1007.00	1007.00	110.90	330.80
461	5073.30	1007.00	.00	.00	.00
46U	5073.60	1007.00	.00	.00	.00
46V	5073.90	1007.00	.00	.00	.00
46W	5074.20	1007.00	.00	.00	.00
46Y	5074.50	1133.00	1133.00	110.95	330.65
471	5074.80	1008.00	.00	.00	.00
47L	5075.10	1008.00	.00	.00	.00
47V	5075.40	1008.00	.00	.00	.00
47W	5075.70	1008.00	.00	.00	.00
48X	5076.00	1009.00	1009.00	111.10	331.70
481	5076.30	1009.00	.00	.00	.00
48U	5076.60	1009.00	.00	.00	.00
48V	5076.90	1009.00	.00	.00	.00
48W	5077.20	1009.00	.00	.00	.00
48Y	5077.50	1125.00	1125.00	111.15	331.55
491	5077.80	1010.00	.00	.00	.00
49U	5078.10	1010.00	.00	.00	.00
49V	5078.40	1010.00	.00	.00	.00
49W	5078.70	1010.00	.00	.00	.00
50X	5079.00	1011.00	1011.00	111.30	332.30
501	5079.30	1011.00	.00	.00	.00
50U	5079.60	1011.00	.00	.00	.00
50V	5079.90	1011.00	.00	.00	.00
50W	5080.20	1011.00	.00	.00	.00
50Y	5080.50	1127.00	1127.00	111.35	332.15
511	5080.80	1012.00	.00	.00	.00
51U	5081.10	1012.00	.00	.00	.00
51V	5081.40	1012.00	.00	.00	.00
51W	5081.70	1012.00	.00	.00	.00
52X	5082.00	1013.00	1013.00	111.50	332.90
521	5082.30	1013.00	.00	.00	.00
52L	5082.60	1013.00	.00	.00	.00

TABLE C-1  
(Page 4 of 4)

52V	5082.90	1013.00	.00	.00	.00
52V	5082.20	1013.00	.00	.00	.00
52Y	5083.50	1129.00	1139.00	111.55	332.75
53T	5083.80	1014.00	.00	.00	.00
53U	5084.10	1014.00	.00	.00	.00
53V	5084.40	1014.00	.00	.00	.00
53W	5084.70	1014.00	.00	.00	.00
54X	5085.00	1015.00	1015.00	111.70	332.50
54Y	5085.30	1015.00	.00	.00	.00
54U	5085.60	1015.00	.00	.00	.00
54V	5085.90	1015.00	.00	.00	.00
54W	5086.20	1015.00	.00	.00	.00
54Y	5086.50	1141.00	1141.00	111.75	333.35
55T	5086.80	1016.00	.00	.00	.00
55U	5087.10	1016.00	.00	.00	.00
55V	5087.40	1016.00	.00	.00	.00
55W	5087.70	1016.00	.00	.00	.00
56X	5088.00	1017.00	1017.00	111.90	331.10
56Y	5088.30	1017.00	.00	.00	.00
56U	5088.60	1017.00	.00	.00	.00
56V	5088.90	1017.00	.00	.00	.00
56W	5089.20	1017.00	.00	.00	.00
56Y	5089.50	1143.00	1143.00	111.95	330.95
57T	5089.80	1018.00	.00	.00	.00
57U	5090.10	1018.00	.00	.00	.00
57V	5090.40	1018.00	.00	.00	.00
57W	5090.70	1018.00	.00	.00	.00

- |    |   |
|----|---|
| 57 | Channels created by multiplexing an additional pulse-pair spacing some high-band en route X channels (58Z-126Z) |
| 2  | Channels undefined (test channels).   |

TABLE C-2 is a listing of the frequencies and related channel numbers contained in "the O8C Plan."

#### RIO CHANNEL PLAN

During the AWOP Working Group M/4 meeting in Rio de Janeiro, Brazil, in 1980, the Federal Republic of Germany submitted another channel plan to be considered for use with MLS. This channel plan combined some features of both the Seattle and O8C plans and contains 200 DME/P channels in L-Band as follows.

- |    |  |
|----|--|
| 40 | Channels shared with ILS-DME (18-56, even X,Y)   |
| 80 | Channels created by multiplexing two additional pulse-pair spacings on the existing 20 ILS-DME X channels (18-56 even, W and Z) and also on the existing en route X channels which are between the ILS channels (19-57 odd, W and Z) |
| 80 | Channels created by multiplexing two additional pulse-pair spacings on some high-band en route X channels (80-119, W and Z).   |

TABLE C-3 is a listing of the frequencies and related channels numbers contained in the "Rio Channel Plan."

#### MONTREAL CHANNEL PLAN

At an informal meeting of the AWOP Working Group M/4 members during the ICAO Communications Divisional Meeting in Montreal, Canada, in 1981, the United Kingdom submitted a channelization idea with an incomplete channel plan

TABLE C-2  
THE OBC CHANNEL PLAN

(Page 1 of 4)

CHANNEL	C-BAND	PCME	CONVENTIONAL	VOR/ILS	GLIDESLOPE
NUM	(MHZ)	L-BAND (MHZ)	L-BAND (MHZ)	(MHZ)	
18X	5031.60	979.00	979.00	108.10	334.70
18Y	5031.90	1105.00	1105.00	108.15	334.55
18XZ	5032.20	979.00	.00	.00	.00
19Y	5032.50	1106.00	1106.00	108.25	.00
19XZ	5032.80	980.00	.00	.00	.00
20X	5033.10	981.00	981.00	108.30	334.10
20Y	5033.40	1107.00	1107.00	108.35	334.95
20XZ	5033.70	981.00	.00	.00	.00
21Y	5034.00	1108.00	1108.00	108.45	.00
21XZ	5034.30	982.00	.00	.00	.00
22X	5034.60	983.00	983.00	108.50	329.90
22Y	5034.90	1109.00	1109.00	108.55	329.75
22XZ	5035.20	983.00	.00	.00	.00
23Y	5035.50	1110.00	1110.00	108.65	.00
23XZ	5035.80	984.00	.00	.00	.00
24X	5036.10	985.00	985.00	108.70	330.50
24Y	5036.40	1111.00	1111.00	108.75	330.35
24XZ	5036.70	985.00	.00	.00	.00
25Y	5037.00	1112.00	1112.00	108.85	.00
25XZ	5037.30	986.00	.00	.00	.00
26Y	5037.60	987.00	987.00	108.90	329.30
26XZ	5037.90	1113.00	1113.00	108.95	329.15
27Y	5038.20	987.00	.00	.00	.00
27XZ	5038.50	1114.00	1114.00	109.05	.00
28Y	5038.80	988.00	.00	.00	.00
28XZ	5039.10	989.00	989.00	109.10	331.40
29Y	5039.40	1115.00	1115.00	109.15	331.25
29XZ	5039.70	989.00	.00	.00	.00
30Y	5040.00	1116.00	1116.00	109.25	.00
30XZ	5040.30	990.00	.00	.00	.00
31Y	5040.60	991.00	991.00	109.30	332.00
31XZ	5040.90	1117.00	1117.00	109.35	331.85
32Y	5041.20	991.00	.00	.00	.00
32XZ	5041.50	1118.00	1118.00	109.45	.00
33Y	5041.80	992.00	.00	.00	.00
33XZ	5042.10	993.00	993.00	109.50	332.60
34Y	5042.40	1119.00	1119.00	109.55	332.45
34XZ	5042.70	993.00	.00	.00	.00
35Y	5043.00	1120.00	1120.00	109.65	.00
35XZ	5043.30	994.00	.00	.00	.00
36Y	5043.60	995.00	995.00	109.70	333.20
36XZ	5043.90	1121.00	1121.00	109.75	333.05
37Y	5044.20	995.00	.00	.00	.00
37XZ	5044.50	1122.00	1122.00	109.85	.00
38Y	5044.80	996.00	.00	.00	.00
38XZ	5045.10	997.00	997.00	109.90	333.80
39Y	5045.40	1123.00	1123.00	109.95	333.65
39XZ	5045.70	997.00	.00	.00	.00
40Y	5046.00	1124.00	1124.00	110.05	.00
40XZ	5046.30	998.00	.00	.00	.00
41Y	5046.60	999.00	999.00	110.10	334.40
41XZ	5046.90	1125.00	1125.00	110.15	334.25
42Y	5047.20	999.00	.00	.00	.00
42XZ	5047.50	1126.00	1126.00	110.25	.00
43Y	5047.80	1000.00	.00	.00	.00

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40X	5048.10	1001.00	1001.00	110.30	335.00
40Y	5048.40	1127.00	1127.00	110.35	334.85
40XZ	5048.40	1001.00	.00	.00	.00
41Y	5049.00	1128.00	1128.00	110.45	.00
41XZ	5049.30	1002.00	.00	.00	.00
42X	5049.60	1003.00	1003.00	110.50	329.60
42Y	5049.90	1129.00	1129.00	110.55	329.45
42XZ	5050.20	1003.00	.00	.00	.00
43Y	5050.50	1130.00	1130.00	110.65	.00
43XZ	5050.80	1004.00	.00	.00	.00
44Y	5051.10	1005.00	1005.00	110.70	330.20
44XZ	5051.40	1131.00	1131.00	110.75	330.05
45Y	5051.70	1005.00	.00	.00	.00
45XZ	5052.00	1132.00	1132.00	110.85	.00
46Y	5052.30	1006.00	.00	.00	.00
46XZ	5052.60	1007.00	1007.00	110.90	330.80
47Y	5052.90	1133.00	1133.00	110.95	330.65
47XZ	5053.20	1007.00	.00	.00	.00
48Y	.00	.00	1134.00	111.00	.00
48XZ	5053.50	1008.00	.00	.00	.00
49Y	5053.80	1009.00	1009.00	111.10	331.70
49XZ	5054.10	1135.00	1135.00	111.15	331.55
50Y	5054.40	1009.00	.00	.00	.00
50XZ	.00	.00	1136.00	111.20	.00
51Y	5054.70	1010.00	.00	.00	.00
51XZ	5055.00	1011.00	1011.00	111.30	332.30
52Y	5055.30	1012.00	1012.00	111.35	332.15
52XZ	5055.60	1011.00	.00	.00	.00
53Y	.00	.00	1137.00	111.40	.00
53XZ	5055.90	1012.00	.00	.00	.00
54Y	5056.20	1013.00	1013.00	111.50	332.90
54XZ	5056.50	1139.00	1139.00	111.55	332.75
55Y	5056.80	1013.00	.00	.00	.00
55XZ	.00	.00	1140.00	111.60	.00
56Y	5057.10	1014.00	.00	.00	.00
56XZ	5057.40	1015.00	1015.00	111.70	333.50
57Y	5057.70	1141.00	1141.00	111.75	333.35
57XZ	5058.00	1015.00	.00	.00	.00
58Y	.00	.00	1142.00	111.80	.00
58XZ	5058.30	1016.00	.00	.00	.00
59Y	5058.60	1017.00	1017.00	111.90	334.10
59XZ	5058.90	1143.00	1143.00	111.95	333.95
60Y	5059.20	1017.00	.00	.00	.00
60XZ	5059.50	1018.00	.00	.00	.00
61Y	5059.80	1019.00	.00	.00	.00
61XZ	5060.10	1020.00	.00	.00	.00
62Y	5060.40	1159.00	.00	.00	.00
62XZ	5060.70	1160.00	.00	.00	.00
63Y	5061.00	1161.00	.00	.00	.00
63XZ	5061.30	1162.00	.00	.00	.00
64Y	5061.60	1163.00	.00	.00	.00
64XZ	5061.90	1164.00	.00	.00	.00
65Y	5062.20	1029.00	1029.00	.00	.00
65XZ	5062.50	1165.00	.00	.00	.00
66Y	5062.80	1040.00	1040.00	.00	.00
66XZ	5063.10	1166.00	.00	.00	.00
67Y	5063.40	1041.00	1041.00	113.35	.00
67XZ	5063.70	1167.00	.00	.00	.00
68Y	5064.00	1042.00	1042.00	113.45	.00

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81XZ	5064.20	1168.00	.00	.00	.00
82Y	5064.60	1043.00	1043.00	113.35	.00
82XZ	5064.90	1169.00	.00	.00	.00
83Y	5065.20	1044.00	1044.00	113.65	.00
83XZ	5065.50	1170.00	.00	.00	.00
84Y	5065.80	1045.00	1045.00	113.75	.00
84XZ	5066.10	1171.00	.00	.00	.00
85Y	5066.40	1046.00	1046.00	113.85	.00
85XZ	5066.70	1172.00	.00	.00	.00
86Y	5067.00	1047.00	1047.00	113.95	.00
86XZ	5067.30	1173.00	.00	.00	.00
87Y	5067.60	1048.00	1048.00	114.05	.00
87XZ	5067.90	1174.00	.00	.00	.00
88Y	5068.20	1049.00	1049.00	114.15	.00
88XZ	5068.50	1175.00	.00	.00	.00
89Y	5068.80	1050.00	1050.00	114.25	.00
89XZ	5069.10	1176.00	.00	.00	.00
90Y	5069.40	1051.00	1051.00	114.35	.00
90XZ	5069.70	1177.00	.00	.00	.00
91Y	5070.00	1052.00	1052.00	114.45	.00
91XZ	5070.30	1178.00	.00	.00	.00
92Y	5070.60	1053.00	1053.00	114.55	.00
92XZ	5070.90	1179.00	.00	.00	.00
93Y	5071.20	1054.00	1054.00	114.65	.00
93XZ	5071.50	1180.00	.00	.00	.00
94Y	5071.80	1055.00	1055.00	114.75	.00
94XZ	5072.10	1181.00	.00	.00	.00
95Y	5072.40	1056.00	1056.00	114.85	.00
95XZ	5072.70	1182.00	.00	.00	.00
96Y	5073.00	1057.00	1057.00	114.95	.00
96XZ	5073.30	1183.00	.00	.00	.00
97Y	5073.60	1058.00	1058.00	115.05	.00
97XZ	5073.90	1184.00	.00	.00	.00
98Y	5074.20	1059.00	1059.00	115.15	.00
98XZ	5074.50	1185.00	.00	.00	.00
99Y	5074.80	1060.00	1060.00	115.25	.00
99XZ	5075.10	1186.00	.00	.00	.00
100Y	5075.40	1061.00	1061.00	115.35	.00
100XZ	5075.70	1187.00	.00	.00	.00
101Y	5076.00	1062.00	1062.00	115.45	.00
101XZ	5076.30	1188.00	.00	.00	.00
102Y	5076.60	1063.00	1063.00	115.55	.00
102XZ	5076.90	1189.00	.00	.00	.00
103Y	5077.20	1064.00	1064.00	115.65	.00
103XZ	5077.50	1190.00	.00	.00	.00
104Y	5077.80	1065.00	1065.00	115.75	.00
104XZ	5078.10	1191.00	.00	.00	.00
105Y	5078.40	1066.00	1066.00	115.85	.00
105XZ	5078.70	1192.00	.00	.00	.00
106Y	5079.00	1067.00	1067.00	115.95	.00
106XZ	5079.30	1193.00	.00	.00	.00
107Y	5079.60	1068.00	1068.00	116.05	.00
107XZ	5079.90	1194.00	.00	.00	.00
108Y	5080.20	1069.00	1069.00	116.15	.00
108XZ	5080.50	1195.00	.00	.00	.00
109Y	5080.80	1070.00	1070.00	116.25	.00
109XZ	5081.10	1196.00	.00	.00	.00
110Y	5081.40	1071.00	1071.00	116.35	.00
110XZ	5081.70	1197.00	.00	.00	.00

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111Y	5082.00	1072.00	1072.00	116.45	.00
111XZ	5082.30	1158.00	.00	.00	.00
112Y	5082.60	1073.00	1073.00	116.55	.00
112XZ	5082.90	1159.00	.00	.00	.00
113Y	5083.20	1074.00	1074.00	116.65	.00
113XZ	5083.50	1200.00	.00	.00	.00
114Y	5083.80	1075.00	1075.00	116.75	.00
114XZ	5084.10	1201.00	.00	.00	.00
115Y	5084.40	1076.00	1076.00	116.85	.00
115XZ	5084.70	1202.00	.00	.00	.00
116Y	5085.00	1077.00	1077.00	116.95	.00
116XZ	5085.30	1203.00	.00	.00	.00
117Y	5085.60	1078.00	1078.00	117.05	.00
117XZ	5085.90	1204.00	.00	.00	.00
118Y	5086.20	1079.00	1079.00	117.15	.00
118XZ	5086.50	1205.00	.00	.00	.00
119Y	5086.80	1080.00	1080.00	117.25	.00
119XZ	5087.10	1206.00	.00	.00	.00
120Y	5087.40	1081.00	1081.00	117.35	.00
120XZ	5087.70	1207.00	.00	.00	.00
121Y	5088.00	1082.00	1082.00	117.45	.00
121XZ	5088.30	1208.00	.00	.00	.00
122Y	5088.60	1083.00	1083.00	117.55	.00
122XZ	5088.90	1209.00	.00	.00	.00
123Y	5089.20	1084.00	1084.00	117.65	.00
123XZ	5089.50	1210.00	.00	.00	.00
124Y	5089.80	1085.00	1085.00	117.75	.00
124XZ	5090.10	1211.00	.00	.00	.00
125Y	5090.40	1212.00	.00	.00	.00
126XZ	5090.70	1213.00	.00	.00	.00

TABLE C-3  
THE RIO CHANNEL PLAN  
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CHANNEL	C-BAND	PCME	CONVENTIONAL	VOR/ILS	GLIDESLOPE
NLR	(MHZ)	L-BAND (MHZ)	L-BAND (PHZ)	(MHZ)	
18X	5031.00	979.00	979.00	108.10	334.70
18XZ	5031.20	979.00	979.00	.00	.00
18X	5031.40	979.00	979.00	.00	.00
18Y	5031.90	1105.00	1105.00	108.15	334.55
19XZ	5032.20	980.00	980.00	.00	.00
19X	5032.50	980.00	980.00	.00	.00
19Y	5032.80	981.00	981.00	108.30	334.10
20XZ	5033.10	981.00	981.00	.00	.00
20X	5033.40	981.00	981.00	.00	.00
20Y	5033.70	1107.00	1107.00	108.35	333.95
21XZ	5034.00	982.00	982.00	.00	.00
21X	5034.20	982.00	982.00	.00	.00
21Y	5034.60	983.00	983.00	108.50	329.90
22XZ	5034.90	983.00	983.00	.00	.00
22X	5035.20	983.00	983.00	.00	.00
22Y	5035.50	983.00	983.00	108.55	329.75
23XZ	5035.80	984.00	984.00	.00	.00
23X	5036.10	984.00	984.00	.00	.00
23Y	5036.40	985.00	985.00	108.70	330.50
24XZ	5036.70	985.00	985.00	.00	.00
24X	5037.00	985.00	985.00	.00	.00
24Y	5037.30	1111.00	1111.00	108.75	330.35
25XZ	5037.60	986.00	986.00	.00	.00
25X	5037.90	986.00	986.00	.00	.00
25Y	5038.20	987.00	987.00	108.90	329.30
26XZ	5038.50	987.00	987.00	.00	.00
26X	5038.80	987.00	987.00	.00	.00
26Y	5039.10	1113.00	1113.00	108.95	329.15
27XZ	5039.40	988.00	988.00	.00	.00
27X	5039.70	988.00	988.00	.00	.00
27Y	5040.00	989.00	989.00	109.10	331.40
28XZ	5040.20	989.00	989.00	.00	.00
28X	5040.50	989.00	989.00	.00	.00
28Y	5040.80	1115.00	1115.00	109.15	331.25
29XZ	5041.20	990.00	990.00	.00	.00
29X	5041.50	990.00	990.00	.00	.00
29Y	5041.80	991.00	991.00	109.30	332.00
30XZ	5042.10	991.00	991.00	.00	.00
30X	5042.40	991.00	991.00	.00	.00
30Y	5042.70	1117.00	1117.00	109.35	331.85
31XZ	5043.00	992.00	992.00	.00	.00
31X	5043.30	992.00	992.00	.00	.00
31Y	5043.60	993.00	993.00	109.50	332.60
32XZ	5043.90	993.00	993.00	.00	.00
32X	5044.20	993.00	993.00	.00	.00
32Y	5044.50	1119.00	1119.00	109.55	332.45
33XZ	5044.80	994.00	994.00	.00	.00
33X	5045.10	994.00	994.00	.30	.05
33Y	5045.40	995.00	995.00	109.70	333.20
34XZ	5045.70	995.00	995.00	.00	.00
34X	5046.00	995.00	995.00	.00	.00
34Y	5046.30	1121.00	1121.00	109.75	333.05
35XZ	5046.60	996.00	996.00	.00	.00
35X	5046.90	996.00	996.00	.00	.00
36X	5047.20	997.00	997.00	109.90	332.80

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36XZ	5047.50	997.00	997.00	.00	.00
36W	5047.80	997.00	997.00	.00	.00
36Y	5048.10	1123.00	1123.00	109.95	333.65
37XZ	5048.40	998.00	998.00	.00	.00
37W	5048.70	998.00	998.00	.00	.00
38X	5049.00	999.00	999.00	110.10	334.40
38XZ	5049.30	999.00	999.00	.00	.00
38W	5049.60	999.00	999.00	.00	.00
38Y	5049.90	1125.00	1125.00	110.15	334.25
39XZ	5050.20	1000.00	1000.00	.00	.00
39W	5050.50	1000.00	1000.00	.00	.00
40X	5050.80	1001.00	1001.00	110.30	335.00
40XZ	5051.10	1001.00	1001.00	.00	.00
40W	5051.40	1001.00	1001.00	.00	.00
40Y	5051.70	1127.00	1127.00	110.25	334.85
41XZ	5052.00	1002.00	1002.00	.00	.00
41W	5052.30	1002.00	1002.00	.00	.00
42X	5052.60	1003.00	1003.00	110.50	329.60
42XZ	5052.90	1003.00	1003.00	.00	.00
42W	5053.20	1003.00	1003.00	.00	.00
42Y	5053.50	1129.00	1129.00	110.55	329.45
43XZ	5053.80	1004.00	1004.00	.00	.00
43W	5054.10	1004.00	1004.00	.00	.00
44X	5054.40	1005.00	1005.00	110.70	330.20
44XZ	5054.70	1005.00	1005.00	.00	.00
44W	5055.00	1005.00	1005.00	.00	.00
44Y	5055.30	1131.00	1131.00	110.75	330.05
45XZ	5055.60	1006.00	1006.00	.00	.00
45W	5055.90	1006.00	1006.00	.00	.00
46X	5056.20	1007.00	1007.00	110.90	330.80
46XZ	5056.50	1007.00	1007.00	.00	.00
46W	5056.80	1007.00	1007.00	.00	.00
46Y	5057.10	1133.00	1133.00	110.95	330.65
47XZ	5057.40	1008.00	1008.00	.00	.00
47W	5057.70	1008.00	1008.00	.00	.00
48X	5058.00	1009.00	1009.00	111.10	331.70
48XZ	5058.30	1009.00	1009.00	.00	.00
48W	5058.60	1009.00	1009.00	.00	.00
48Y	5058.90	1135.00	1135.00	111.15	331.55
49XZ	5059.20	1010.00	1010.00	.00	.00
49W	5059.50	1010.00	1010.00	.00	.00
50X	5059.80	1011.00	1011.00	111.30	332.30
50XZ	5060.10	1011.00	1011.00	.00	.00
50W	5060.40	1011.00	1011.00	.00	.00
50Y	5060.70	1137.00	1137.00	111.35	332.15
51XZ	5061.00	1012.00	1012.00	.00	.00
51W	5061.30	1012.00	1012.00	.00	.00
52X	5061.60	1013.00	1013.00	111.50	332.90
52XZ	5061.90	1013.00	1013.00	.00	.00
52W	5062.20	1013.00	1013.00	.00	.00
52Y	5062.50	1139.00	1139.00	111.55	332.75
53XZ	5062.80	1014.00	1014.00	.00	.00
53W	5063.10	1014.00	1014.00	.00	.00
54X	5063.40	1015.00	1015.00	111.70	333.50
54XZ	5063.70	1015.00	1015.00	.00	.00
54W	5064.00	1015.00	1015.00	.00	.00
54Y	5064.30	1141.00	1141.00	111.75	333.35
55XZ	5064.60	1016.00	1016.00	.00	.00
55W	5064.90	1016.00	1016.00	.00	.00

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56X	5065.20	1017.00	1017.00	111.90	331.10
56XZ	5065.50	1017.00	1017.00	.00	.00
56L	5065.80	1017.00	1017.00	.00	.00
56Y	5066.10	1143.00	1143.00	111.95	330.95
57XZ	5066.40	1018.00	1018.00	.00	.00
57L	5066.70	1018.00	1018.00	.00	.00
80XZ	5067.30	1167.00	1167.00	.00	.00
80L	5067.60	1168.00	1168.00	.00	.00
81XZ	5067.90	1168.00	1168.00	.00	.00
81L	5068.20	1169.00	1169.00	.00	.00
82XZ	5068.50	1169.00	1169.00	.00	.00
82L	5068.80	1170.00	1170.00	.00	.00
83XZ	5069.10	1170.00	1170.00	.00	.00
83L	5069.40	1171.00	1171.00	.00	.00
84XZ	5069.70	1171.00	1171.00	.00	.00
84L	5070.00	1172.00	1172.00	.00	.00
85XZ	5070.30	1172.00	1172.00	.00	.00
85L	5070.60	1173.00	1173.00	.00	.00
86XZ	5070.90	1173.00	1173.00	.00	.00
86L	5071.20	1174.00	1174.00	.00	.00
87XZ	5071.50	1174.00	1174.00	.00	.00
87L	5071.80	1175.00	1175.00	.00	.00
88XZ	5072.10	1175.00	1175.00	.00	.00
88L	5072.40	1176.00	1176.00	.00	.00
89XZ	5072.70	1176.00	1176.00	.00	.00
89L	5073.00	1177.00	1177.00	.00	.00
90XZ	5073.30	1177.00	1177.00	.00	.00
90L	5073.60	1178.00	1178.00	.00	.00
91XZ	5073.90	1178.00	1178.00	.00	.00
91L	5074.20	1179.00	1179.00	.00	.00
92XZ	5074.50	1179.00	1179.00	.00	.00
92L	5074.80	1180.00	1180.00	.00	.00
93XZ	5075.10	1180.00	1180.00	.00	.00
93L	5075.40	1181.00	1181.00	.00	.00
94XZ	5075.70	1181.00	1181.00	.00	.00
94L	5076.00	1182.00	1182.00	.00	.00
95XZ	5076.30	1182.00	1182.00	.00	.00
95L	5076.60	1183.00	1183.00	.00	.00
96XZ	5076.90	1183.00	1183.00	.00	.00
96L	5077.20	1184.00	1184.00	.00	.00
97XZ	5077.50	1184.00	1184.00	.00	.00
97L	5077.80	1185.00	1185.00	.00	.00
98XZ	5078.10	1185.00	1185.00	.00	.00
98L	5078.40	1186.00	1186.00	.00	.00
99XZ	5078.70	1186.00	1186.00	.00	.00
99L	5079.00	1187.00	1187.00	.00	.00
100XZ	5079.30	1187.00	1187.00	.00	.00
100L	5079.60	1188.00	1188.00	.00	.00
101XZ	5079.90	1188.00	1188.00	.00	.00
101L	5080.20	1189.00	1189.00	.00	.00
102XZ	5080.50	1189.00	1189.00	.00	.00
102L	5080.80	1190.00	1190.00	.00	.00
103XZ	5081.10	1190.00	1190.00	.00	.00
103L	5081.40	1191.00	1191.00	.00	.00
104XZ	5081.70	1191.00	1191.00	.00	.00
104L	5082.00	1192.00	1192.00	.00	.00
105XZ	5082.30	1192.00	1192.00	.00	.00
105L	5082.60	1193.00	1193.00	.00	.00

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106W	5082.93	1193.00	1193.00	.00	.00
107XZ	5083.20	1194.00	1194.00	.00	.00
107L	5083.50	1194.00	1194.00	.00	.00
108XZ	5083.80	1195.00	1195.00	.00	.00
108W	5084.10	1195.00	1195.00	.00	.00
109XZ	5084.40	1196.00	1196.00	.00	.00
109L	5084.70	1196.00	1196.00	.00	.00
110XZ	5085.00	1197.00	1197.00	.00	.00
110L	5085.30	1197.00	1197.00	.00	.00
111XZ	5085.60	1198.00	1198.00	.00	.00
111W	5085.90	1198.00	1198.00	.00	.00
112XZ	5086.20	1199.00	1199.00	.00	.00
112W	5086.50	1199.00	1199.00	.00	.00
113XZ	5086.80	1200.00	1200.00	.00	.00
113L	5087.10	1200.00	1200.00	.00	.00
114XZ	5087.40	1201.00	1201.00	.00	.00
114L	5087.70	1201.00	1201.00	.00	.00
115XZ	5088.00	1202.00	1202.00	.00	.00
115L	5088.30	1202.00	1202.00	.00	.00
116XZ	5088.60	1203.00	1203.00	.00	.00
116W	5088.90	1203.00	1203.00	.00	.00
117XZ	5089.20	1204.00	1204.00	.00	.00
117W	5089.50	1204.00	1204.00	.00	.00
118XZ	5089.80	1205.00	1205.00	.00	.00
118L	5090.10	1205.00	1205.00	.00	.00
119XZ	5090.40	1206.00	1206.00	.00	.00
119W	5090.70	1206.00	1206.00	.00	.00

(not 200 channels) for use with MLS. This channel plan is unique in that it does not attempt to define any new pulse multiplexing. The intent of not completing the channel plan by defining the entire 200-channel set was to allow a better selection of those channels after some operational experience was gained or, if 200 channels were not required, not to define the 200-channel set. This channel plan is as follows.

- |    |   |
|----|---|
| 40 | Channels shared with ILS-DME (18-56 even, X,Y)  |
| 20 | Created by redefining some high-band en route Y<br>channels for MLS use (80Y-118Y, even). |

TABLE C-4 is a listing of the frequencies and related channel numbers contained in the "Montreal Channel Plan."

TABLE C-4  
THE MONTREAL CHANNEL PLAN

(Page 1 of 2)

WGT FREQ/UNIT/TYPE CHANNEL	C-BAND	POPE	CONVENTIONAL	VOR/ILS	GLIDESLOPE
NLM	(MHZ)	L-BAND (MHZ)	L-BAND (MHZ)	(MHZ)	
18X	5021.00	977.00	977.00	108.10	334.7
18Y	5021.90	1107.00	1107.00	108.15	334.55
20X	5022.80	981.00	981.00	108.30	334.10
20Y	5023.70	1107.00	1107.00	108.35	333.95
22X	5024.60	983.00	983.00	108.50	329.90
22Y	5025.50	983.00	983.00	108.55	329.75
24X	5026.40	983.00	983.00	108.70	330.50
24Y	5027.30	1111.00	1111.00	108.75	330.35
26X	5028.20	987.00	987.00	108.90	329.30
26Y	5029.10	1113.00	1113.00	108.95	329.15
28X	5030.00	987.00	987.00	109.10	331.40
28Y	5030.90	1113.00	1113.00	109.15	331.25
30X	5031.80	991.00	991.00	109.30	332.00
30Y	5032.70	1117.00	1117.00	109.35	331.85
32X	5033.60	993.00	993.00	109.50	332.00
32Y	5034.50	1119.00	1119.00	109.55	332.45
34X	5035.40	995.00	995.00	109.70	333.20
34Y	5036.30	1121.00	1121.00	109.75	333.05
36X	5037.20	997.00	997.00	109.90	333.80
36Y	5038.10	1123.00	1123.00	109.95	333.65
38X	5039.00	999.00	999.00	110.10	334.40
38Y	5039.90	1125.00	1125.00	110.15	334.25
40X	5040.80	1001.00	1001.00	110.30	335.00
40Y	5041.70	1127.00	1127.00	110.35	334.85
42X	5042.60	1003.00	1003.00	110.50	329.6
42Y	5043.50	1129.00	1129.00	110.55	329.45
44X	5044.40	1005.00	1005.00	110.70	330.20
44Y	5045.30	1131.00	1131.00	110.75	330.05
46X	5046.20	1007.00	1007.00	110.90	330.8
46Y	5047.10	1133.00	1133.00	110.95	330.65
48X	5048.00	1009.00	1009.00	111.10	331.70
48Y	5048.90	1135.00	1135.00	111.15	331.55
50X	5049.80	1011.00	1011.00	111.30	332.00
50Y	5050.70	1137.00	1137.00	111.35	332.15
52X	5051.60	1013.00	1013.00	111.50	332.90
52Y	5052.50	1139.00	1139.00	111.55	332.75
54X	5053.40	1015.00	1015.00	111.70	333.00
54Y	5054.30	1141.00	1141.00	111.75	333.30
56X	5055.20	1017.00	1017.00	111.90	331.10
56Y	5056.10	1143.00	1143.00	111.95	330.95
58X	5057.00	1019.00	1019.00	112.10	331.00
58Y	5057.90	1145.00	1145.00	112.15	331.15
60X	5058.80	1021.00	1021.00	112.30	331.30
60Y	5059.70	1147.00	1147.00	112.35	331.45
62X	5060.60	1023.00	1023.00	112.50	331.60
62Y	5061.50	1149.00	1149.00	112.55	331.75
64X	5062.40	1025.00	1025.00	112.65	331.85
64Y	5063.30	1151.00	1151.00	112.70	331.90
66X	5064.20	1027.00	1027.00	112.80	332.00
66Y	5065.10	1153.00	1153.00	112.85	332.05
68X	5066.00	1029.00	1029.00	112.95	332.15
68Y	5066.90	1155.00	1155.00	113.00	332.20
70X	5067.80	1031.00	1031.00	113.10	332.30
70Y	5068.70	1157.00	1157.00	113.15	332.35
72X	5069.60	1033.00	1033.00	113.25	332.45
72Y	5070.50	1159.00	1159.00	113.30	332.50
74X	5071.40	1035.00	1035.00	113.40	332.60
74Y	5072.30	1161.00	1161.00	113.45	332.65
76X	5073.20	1037.00	1037.00	113.55	332.75
76Y	5074.10	1163.00	1163.00	113.60	332.80
78X	5075.00	1039.00	1039.00	113.65	332.90
78Y	5075.90	1165.00	1165.00	113.70	332.95
80X	5076.80	1041.00	1041.00	113.75	333.05
80Y	5077.70	1167.00	1167.00	113.80	333.10
82X	5078.60	1043.00	1043.00	113.85	333.20
82Y	5079.50	1169.00	1169.00	113.90	333.25
84X	5080.40	1045.00	1045.00	114.00	333.35
84Y	5081.30	1171.00	1171.00	114.05	333.40

TABLE C-4  
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86Y	5029.70	1047.00	1047.00	113.95	.0
88Y	5070.60	1043.00	1043.00	114.15	.0
90Y	5071.50	1041.00	1041.00	114.35	.0
92Y	5072.40	1040.00	1040.00	114.55	.0
94Y	5073.30	1039.00	1039.00	114.75	.0
96Y	5074.20	1037.00	1037.00	114.95	.0
98Y	5075.10	1036.00	1036.00	115.15	.0
100Y	5076.00	1035.00	1035.00	115.35	.0
102Y	5076.90	1033.00	1033.00	115.55	.0
104Y	5077.80	1035.00	1035.00	115.75	.0
106Y	5078.70	1037.00	1037.00	115.95	.0
108Y	5079.60	1039.00	1039.00	116.15	.0
110Y	5080.50	1041.00	1041.00	116.35	.0
112Y	5081.40	1043.00	1043.00	116.55	.0
114Y	5082.30	1045.00	1045.00	116.75	.0
116Y	5083.20	1047.00	1047.00	116.95	.0
118Y	5084.10	1049.00	1049.00	117.15	.0

APPENDIX D  
AMSTERDAM CHANNEL PLAN

A draft channel plan, as provided in TABLE D-1, was presented and discussed in broad terms during the last day of a meeting of the MLS Channel Plans and Traffic-Loading Subgroup in Amsterdam, in August 1981. The subgroup was unable in the time available to study the proposed plan in detail, but agreed it had merit and recommended that Working Group "M" should give it careful consideration. Some of the related aspects discussed by the subgroup were as follows.

1. As compared to earlier channel plans, the draft plan reduces the potential for traffic-loading problems.

2. Implementation of the draft plan would extend the period of time over which conventional DME/N equipment is interoperable with DME/P equipment.

3. The draft plan provides for a more nearly optimum pairing of C-Band and L-Band frequencies than do other plans.

The Amsterdam Channel Plan contains 200 DME/P channels in L-Band as follows.

40	Channels shared with ILS-DME (18-56 even, X and Y)
60	Channels created by sharing or redefining en route Y channels for MLS use (17Y-55Y and 80Y-119Y)
100	Channels created by multiplexing an additional pulse-pair spacing on each of the above channels (XZ and ZY).

TABLE D-1  
AMSTERDAM CHANNEL PLAN  
(Page 1 of 4)

CHANNEL NUMBER	C-BAND (MHZ)	DME-P (MHZ)	DME-V (MHZ)	VOR/IL (MHZ)	GLIDE SLOPE (MHZ)
17Y	5043.90	1104.00	1104.00	108.15	.00
17ZY	5043.30	1104.00	1104.00	.00	.00
18X	5031.90	974.00	974.00	108.10	334.70
18XZ	5031.30	974.00	974.00	.00	.00
18Y	5043.60	1105.00	1105.00	108.15	334.55
18ZY	5043.90	1105.00	1105.00	.00	.00
19Y	5044.20	1105.00	1105.00	108.25	.00
19ZY	5044.50	1105.00	1105.00	.00	.00
20X	5031.60	981.00	981.00	108.30	334.10
20XZ	5031.90	981.00	981.00	.00	.00
20Y	5044.80	1107.00	1107.00	108.35	334.95
20ZY	5045.10	1107.00	1107.00	.00	.00
21Y	5045.40	1108.00	1108.00	108.45	.00
21ZY	5045.70	1108.00	1108.00	.00	.00
22X	5032.20	983.00	983.00	108.50	329.90
22XZ	5032.50	983.00	983.00	.00	.00
22Y	5046.00	1109.00	1109.00	108.55	329.75
22ZY	5046.30	1109.00	1109.00	.00	.00
23Y	5046.60	1110.00	1110.00	108.65	.00
23ZY	5046.90	1110.00	1110.00	.00	.00
24X	5032.80	985.00	985.00	108.70	330.50
24XZ	5033.10	985.00	985.00	.00	.00
24Y	5047.20	1111.00	1111.00	108.75	330.35
24ZY	5047.50	1111.00	1111.00	.00	.00
25Y	5047.80	1112.00	1112.00	108.85	.00
25ZY	5048.10	1112.00	1112.00	.00	.00
26X	5033.40	987.00	987.00	108.90	329.30
26XZ	5033.70	987.00	987.00	.00	.00
26Y	5048.40	1113.00	1113.00	108.95	329.15
26ZY	5048.70	1113.00	1113.00	.00	.00
27Y	5049.00	1114.00	1114.00	109.05	.00
27ZY	5059.30	1114.00	1114.00	.00	.00
28X	5034.00	989.00	989.00	109.10	331.40
28XZ	5034.30	989.00	989.00	.00	.00
28Y	5059.60	1115.00	1115.00	109.15	331.25
28ZY	5059.90	1115.00	1115.00	.00	.00
29Y	5050.20	1116.00	1116.00	109.25	.00
29ZY	5050.50	1116.00	1116.00	.00	.00
30X	5034.60	991.00	991.00	109.30	332.00
30XZ	5034.90	991.00	991.00	.00	.00
30Y	5050.80	1117.00	1117.00	109.35	331.85
30ZY	5051.10	1117.00	1117.00	.00	.00
31Y	5051.40	1118.00	1118.00	109.45	.00
31ZY	5051.70	1118.00	1118.00	.00	.00
32X	5035.20	993.00	993.00	109.50	332.00
32XZ	5035.50	993.00	993.00	.00	.00
32Y	5052.00	1119.00	1119.00	109.55	332.45
32ZY	5052.30	1119.00	1119.00	.00	.00
33Y	5052.60	1120.00	1120.00	109.65	.00
33ZY	5052.90	1120.00	1120.00	.00	.00
34X	5035.80	995.00	995.00	109.70	333.20
34XZ	5036.10	995.00	995.00	.00	.00
34Y	5053.20	1121.00	1121.00	109.75	333.05
34ZY	5053.50	1121.00	1121.00	.00	.00
35Y	5053.80	1122.00	1122.00	109.85	.00

TABLE D-1  
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35ZY	5059.13	1121.00	1122.00	.30	333.00
36X	5036.40	997.00	997.00	109.90	.00
36XZ	5136.70	997.00	997.00	.00	333.65
36Y	5059.40	1123.00	1123.00	109.95	.00
36ZY	5054.70	1123.00	1123.00	.00	.00
37Y	5055.10	1124.00	1124.00	110.35	.00
37ZY	5055.30	1124.00	1124.00	.00	.00
38X	5037.00	999.00	999.00	110.10	334.40
38XZ	5037.30	999.00	999.00	.00	.00
38Y	5055.60	1125.00	1125.00	110.15	334.25
38ZY	5055.90	1125.00	1125.00	.00	.00
39Y	5056.20	1126.00	1126.00	110.25	.00
39ZY	5056.50	1126.00	1126.00	.00	.00
40X	5037.60	1001.00	1001.00	110.30	335.00
40XZ	5037.90	1001.00	1001.00	.00	.00
40Y	5056.80	1127.00	1127.00	110.35	334.85
40ZY	5057.10	1127.00	1127.00	.00	.00
41Y	5057.40	1128.00	1128.00	110.45	.00
41ZY	5057.70	1128.00	1128.00	.00	.00
42X	5038.20	1003.00	1003.00	110.50	329.60
42XZ	5038.50	1003.00	1003.00	.00	.00
42Y	5058.00	1129.00	1129.00	110.55	329.45
42ZY	5058.30	1129.00	1129.00	.00	.00
43Y	5058.60	1130.00	1130.00	110.65	.00
43ZY	5058.90	1130.00	1130.00	.00	.00
44X	5039.00	1005.00	1005.00	110.70	330.00
44XZ	5039.10	1005.00	1005.00	.00	.00
44Y	5059.20	1131.00	1131.00	110.75	330.00
44ZY	5059.50	1131.00	1131.00	.00	.00
45Y	5059.80	1132.00	1132.00	110.85	.00
45ZY	5060.10	1132.00	1132.00	.00	.00
46X	5039.40	1007.00	1007.00	110.90	330.00
46XZ	5039.70	1007.00	1007.00	.00	.00
46Y	5060.40	1133.00	1133.00	110.95	330.00
46ZY	5060.70	1133.00	1133.00	.00	.00
47Y	5061.00	1134.00	1134.00	111.05	.00
47ZY	5061.30	1134.00	1134.00	.00	.00
48X	5040.00	1009.00	1009.00	111.10	331.70
48XZ	5040.30	1009.00	1009.00	.00	.00
48Y	5061.60	1135.00	1135.00	111.15	331.55
48ZY	5061.90	1135.00	1135.00	.00	.00
49Y	5062.20	1135.00	1135.00	111.25	.00
49ZY	5062.50	1135.00	1135.00	.00	.00
50X	5040.60	1011.00	1011.00	111.30	332.00
50XZ	5040.90	1011.00	1011.00	.00	.00
50Y	5062.80	1137.00	1137.00	111.35	332.15
50ZY	5063.10	1137.00	1137.00	.00	.00
51Y	5063.40	1138.00	1138.00	111.45	.00
51ZY	5063.70	1138.00	1138.00	.00	.00
52X	5041.20	1013.00	1013.00	111.50	332.90
52XZ	5041.50	1013.00	1013.00	.00	.00
52Y	5064.00	1139.00	1139.00	111.55	332.75
52ZY	5064.30	1139.00	1139.00	.00	.00
53Y	5064.60	1140.00	1140.00	111.65	.00
53ZY	5064.90	1140.00	1140.00	.00	.00
54X	5041.80	1015.00	1015.00	111.70	333.50
54XZ	5042.10	1015.00	1015.00	.00	.00
54Y	5065.20	1141.00	1141.00	111.75	333.35
54ZY	5065.50	1141.00	1141.00	.00	.00

TABLE D-1  
(Page 3 of 4)

55Y	5065.80	1142.00	1142.00	111.85	.00
552Y	5066.10	1142.00	1142.00	.00	.00
56X	5042.40	1017.00	1017.00	111.90	331.10
562X	5042.70	1017.00	1017.00	.00	.00
56Y	5066.40	1143.00	1143.00	111.95	330.95
562Y	5066.70	1143.00	1143.00	.00	.00
80Y	5067.00	1041.00	1041.00	113.35	.00
802Y	5067.30	1041.00	1041.00	.00	.00
81Y	5067.60	1042.00	1042.00	113.45	.00
812Y	5067.90	1042.00	1042.00	.00	.00
82Y	5068.20	1043.00	1043.00	113.55	.00
822Y	5068.50	1043.00	1043.00	.00	.00
83Y	5068.80	1044.00	1044.00	113.55	.00
832Y	5069.10	1044.00	1044.00	.00	.00
84Y	5069.40	1045.00	1045.00	113.75	.00
842Y	5069.70	1045.00	1045.00	.00	.00
85Y	5070.00	1046.00	1046.00	113.85	.00
852Y	5070.30	1046.00	1046.00	.00	.00
86Y	5070.60	1047.00	1047.00	113.95	.00
862Y	5070.90	1047.00	1047.00	.00	.00
87Y	5071.20	1048.00	1048.00	114.05	.00
872Y	5071.50	1048.00	1048.00	.00	.00
88Y	5071.80	1049.00	1049.00	114.15	.00
882Y	5072.10	1049.00	1049.00	.00	.00
89Y	5072.40	1050.00	1050.00	114.25	.00
892Y	5072.70	1050.00	1050.00	.00	.00
90Y	5073.00	1051.00	1051.00	114.35	.00
902Y	5073.30	1051.00	1051.00	.00	.00
91Y	5073.60	1052.00	1052.00	114.45	.00
912Y	5073.90	1052.00	1052.00	.00	.00
92Y	5074.20	1053.00	1053.00	114.55	.00
922Y	5074.50	1053.00	1053.00	.00	.00
93Y	5074.80	1054.00	1054.00	114.65	.00
932Y	5075.10	1054.00	1054.00	.00	.00
94Y	5075.40	1055.00	1055.00	114.75	.00
942Y	5075.70	1055.00	1055.00	.00	.00
95Y	5076.00	1056.00	1056.00	114.85	.00
952Y	5076.30	1056.00	1056.00	.00	.00
96Y	5076.60	1057.00	1057.00	114.95	.00
962Y	5076.90	1057.00	1057.00	.00	.00
97Y	5077.20	1058.00	1058.00	115.05	.00
972Y	5077.50	1058.00	1058.00	.00	.00
98Y	5077.80	1059.00	1059.00	115.15	.00
982Y	5078.10	1059.00	1059.00	.00	.00
99Y	5078.40	1060.00	1060.00	115.25	.00
992Y	5078.70	1060.00	1060.00	.00	.00
100Y	5079.00	1061.00	1061.00	115.35	.00
1002Y	5079.30	1061.00	1061.00	.00	.00
101Y	5079.60	1062.00	1062.00	115.45	.00
1012Y	5079.90	1062.00	1062.00	.00	.00
102Y	5080.20	1063.00	1063.00	115.55	.00
1022Y	5080.50	1063.00	1063.00	.00	.00
103Y	5080.80	1064.00	1064.00	115.65	.00
1032Y	5081.10	1064.00	1064.00	.00	.00
104Y	5081.40	1065.00	1065.00	115.75	.00
1042Y	5081.70	1065.00	1065.00	.00	.00
105Y	5082.00	1066.00	1066.00	115.85	.00
1052Y	5082.30	1066.00	1066.00	.00	.00
106Y	5082.60	1067.00	1067.00	115.95	.00

TABLE D-1  
(Page 4 of 4)

1062Y	5082.90	1067.00	1067.00	.00	.00
<del>107Y</del>	<del>5083.20</del>	1068.00	1068.00	116.05	.00
1072Y	5083.50	1068.00	1068.00	.00	.00
108Y	5083.80	1069.00	1069.00	116.15	.00
<del>1082Y</del>	<del>5084.10</del>	1069.00	1069.00	.00	.00
109Y	5084.40	1070.00	1070.00	116.25	.00
1092Y	5084.70	1070.00	1070.00	.00	.00
<del>110Y</del>	<del>5085.00</del>	1071.00	1071.00	116.35	.00
1102Y	5085.30	1071.00	1071.00	.00	.00
111Y	5085.60	1072.00	1072.00	116.45	.00
<del>1112Y</del>	<del>5085.90</del>	1072.00	1072.00	.00	.00
112Y	5086.20	1073.00	1073.00	116.55	.00
1122Y	5086.50	1073.00	1073.00	.00	.00
<del>113Y</del>	<del>5086.80</del>	1074.00	1074.00	116.65	.00
1132Y	5087.10	1074.00	1074.00	.00	.00
114Y	5087.40	1075.00	1075.00	116.75	.00
<del>1142Y</del>	<del>5087.70</del>	1075.00	1075.00	.00	.00
115Y	5088.00	1076.00	1076.00	116.85	.00
1152Y	5088.30	1076.00	1076.00	.00	.00
<del>116Y</del>	<del>5088.60</del>	1077.00	1077.00	116.95	.00
1162Y	5088.90	1077.00	1077.00	.00	.00
117Y	5089.20	1078.00	1078.00	117.05	.00
<del>1172Y</del>	<del>5089.50</del>	1078.00	1078.00	.00	.00
118Y	5089.80	1079.00	1079.00	117.15	.00
1182Y	5090.10	1079.00	1079.00	.00	.00
<del>119Y</del>	<del>5090.40</del>	1080.00	1080.00	117.25	.00
1192Y	5090.70	1080.00	1080.00	.00	.00

APPENDIX E  
MLS CHANNEL PLAN<sup>7</sup>  
(SUBGROUP REPORT)

INTRODUCTION

Since the initial consideration by the Working Group "M" of a draft channel plan in 1979 that had proposed the use of several times pulse multiplexing, progress has been made in understanding the effects of implementing channel plans regarding traffic loading and the related effects on garbling and system reply efficiency degradation. The conclusion of the working group has been that it was necessary to develop a new channel plan with as little multiplexing as practical in order to minimize the effects of traffic loading. Additional considerations that needed to be reflected in a final channel plan were the effect that the present use of L-Band would have on DME/P implementation if a majority of X channels versus Y channels were included in the channel plan. The issue of long term interoperability with the DME/N equipment was also addressed.

An optimum C-Band/L-Band channel-pairing arrangement was pursued by the working group. A pairing scheme, which reduces unnecessary adjacent-channel constraints, was developed and a decision to use a large number of Y channels as compared to X channels has been agreed upon.

As the various DME/P system concepts matured into the recommended 2-pulse/2-mode system, there arose a need to analyze and define the constituent pulse-pair spacings that will allow this system to operate efficiently and also provide long term interoperability with DME/N equipments.

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<sup>7</sup>MLS Channel Plan, Annex H, Working Group "M" 5 Meeting, 21 September - 2 October 1981, Nevilly, France.

The essential characteristics of the final selected channel plan are:

- Long term interoperability with existing interrogators
- Minimization of interference potential with present en-route systems
- Minimization of garbling potential due to fewer multiplexed channels
- Optimum pairing between C-Band and L-Band.

These various analyses and results that had an effect on the development of the recommended MLS channel plan are noted herein.

#### PULSE MULTIPLEXING VERSUS TRAFFIC LOADING

A conclusion was reached by the working group that the effect on traffic loading (and therefore on garbling potential) was directly proportional to the number of pulse-multiplexed channels that could be defined on one frequency. If many channels can be defined within a given receiver bandwidth through pulse multiplexing, then the potential for the simultaneous occurrence of pulses in the front-end of that receiver is increased, thus resulting in a greater potential for garbling and a reduction in system efficiency. Conversely, a channel plan that spreads the 200 channels over a larger frequency range by limiting the number of channels to be created by multiplexing, will reduce the potential for garbling within that same receiver.

A draft channel plan submitted in Seattle in 1979 had defined 160 of its 200 channels by multiplexing four additional pulse-pair spacings onto the existing low L-Band X channels. This created a total of 5 different channels on each of the X-channel frequencies used.

Another draft channel plan submitted in Rio de Janeiro in 1980 had defined 160 of its 200 channels by multiplexing two additional pulse-pair spacings onto a larger number of X-channel frequencies within the frequency

band. This Rio channel plan created a maximum of 3 channels on each of the X-channel frequencies used.

The reduced multiplexing included in the Rio channel plan was expected to relieve the traffic loading problems that were anticipated to occur if the Seattle plan had been adopted. However, in an analysis of traffic loading using the Rio channel plan and assuming a transponder reply efficiency of 70% as presently specified in ICAO Annex 10, it was estimated that the overall system reply efficiency could fall to about 50%. This analysis showed that the use of the Rio channel plan could result in an overall system efficiency that would be marginally acceptable and led to the conclusion that there would be a benefit in developing a channel plan which would increase this margin.

This traffic loading analysis resulted in the working group's acceptance of a proposed channel plan which had been submitted by a subgroup activity in Amsterdam. This Amsterdam channel plan makes use of 100 existing X and Y channels (20 and 80, respectively) and created an additional 100 channels by multiplexing only one time on each of those X- and Y-channel frequencies. This reduces the number of channels on each frequency by 1/3 and will produce a comparable reduction in the number of garbling pulses.

#### X CHANNELS VERSUS Y CHANNELS

Guided by the results of the traffic-loading analysis, the working group had found it necessary to expand the DME/P channels substantially outside the existing ILS-DME portion of L-band. The decision as to whether to select X channels or Y channels was based primarily on current channel utilization. Information submitted to the working group revealed that only one Y channel is in use in the USA, while less than 1/3 of the available Y channels are being used or planned for use in Europe. This contrasts with the nearly saturated usage of the available X channels in many of the dense areas of the world. As a result, the working group selected Y channels for use with DME/P, whenever the normal ILS-DME channels are not available. A summary of the L-Band portion of the MLS channel is shown in TABLE E-1.

TABLE E-1  
DME/P CHANNEL PLAN SUMMARY

40	Channels shared with ILS-DME (18-56, even X, Y)
60	Channels shared with en-route DME/N (17 Y - 55 Y odd, 80 Y - 119 Y)
100	Channels created by multiplexing one additional pulse-pair spacing on the above 40 and 60 channels.

The working group recognized that while the present use and future growth of en-route systems in the Y channels may require careful frequency management, it was considered there was more flexibility to share these channels than attempting to make use of the X channels. Additionally, it was recognized that appropriate separation standards will need to be developed, considering all the interactions between DME/N and DME/P equipment. It was also noted that the potential for precision/en-route intersystem interference could be reduced by a channel implementation strategy such as initiating channel assignments for precision and new en-route systems at opposite ends of the frequency band.

#### C-BAND AND L-BAND CHANNEL PAIRING

In the working group it was noted that a casual approach to C-Band and L-Band channel pairing could result in unnecessary adjacent channel constraints being built into the channel plan. It should be noted that the new channel plan has been built by pairing C-Band and L-Band (uplink) frequencies sequentially so that an adjacent channel in L-Band is paired with an adjacent channel in C-Band.

#### NEW PULSE CODE SPACINGS

#### Standardization of Reference Timing

The distance measurement and time delay reference used in the existing DME/N system is presently defined relative to the second pulse of the

constituent pair for both the interrogation and reply links. With the advent of DME/P and the precision measurement being determined on the leading edge of the first pulse of the constituent pair, a preference is apparent to change this timing reference to the first pulse. Concerning the matter of interoperability, either the first- or second-pulse timing reference is acceptable provided the present basis of 50  $\mu$ s continues to be maintained with respect to the second pulse for either mode, precision or nonprecision. This will allow continued use of the older equipment with the new precision ground transponders operating in the non-precision mode and this will also require only a single delay adjustment to continue in effect with all the new precision interrogators, regardless of their mode of operation or channel designation.

#### Decoder-Performance

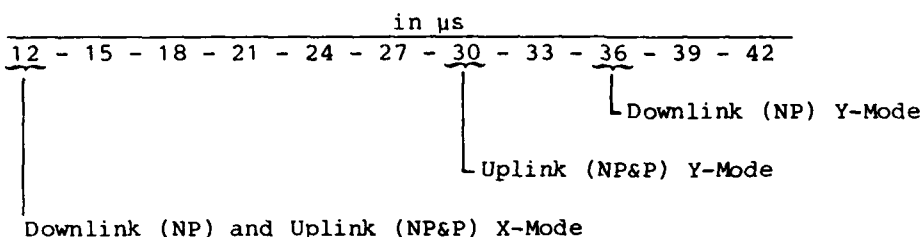
The working group noted that the seven (7) new pulse-code spacings required for full implementation of a channel plan using 2-pulse/2-mode DME/P, require careful consideration of the potential for interaction between DME/P equipment and also those interactions involving DME/N equipment.

One of the most limiting factors in selecting acceptable pulse code spacings was recognized as the relatively wide decoding abilities ( $\approx \pm 6 \mu$ s) of existing DME/N interrogators and also of tube-type transponders. This was compared to the better performance to be obtained from modern DME equipment using digital decoders ( $\approx \pm 3 \mu$ s).

As a result, it is important that pulse-pair spacings with a difference of less than 3  $\mu$ s should not be used and that those spacings with a difference of less than 6  $\mu$ s should be used with discretion, that is, not until the older DME/N equipment is no longer in use or the frequency protection procedures have been provided for such assignments.

Determination of the Pulse Pair Spacing

The possible spacings based on a minimum separation criteria of 3  $\mu$ s, beginning with the lowest acceptable spacing of 12  $\mu$ s (present X-channel spacing), are as follows.



It should be noted that the 12  $\mu$ s was taken as the lowest practical spacing because of the existing 8  $\mu$ s transponder recovery time standard (Annex 10 + present equipment specifications) and the defined precision/non-precision pulse shape characteristics of pulse rise time, width, and fall time. Also, the first choice from these available spacings must be given to the uplink, since it is imperative to always assure on a priority basis the protection at the avionics whenever possible both from a safety, in addition to an economic, standpoint.

When considering the avionics uplink selections, it is also necessary to provide at least  $\approx 6$   $\mu$ s separation between multiplexed channels using the same reply frequencies, i.e., X and ZX (or Y and ZY) in order to protect those existing avionics that have low-performing decoders (large decoder apertures). In addition, the selection in the uplink mode should be limited to the smaller reply spacing, because of the desirability to provide zero-offset with respect to the DME site as a system option.

Finally, uplink codes should be selected which promote minimum design costs, may be accomplished by having constant offsets from precision to non-precision codes, or by having codes divisible, say by a factor of 2, when changing from channel to channel where required.

When reviewing these available codes for the uplink applications, we observe the following:

12  $\mu$ s - Cannot be used as an uplink code on ZX, since this is currently used as the X uplink code. This would result in a cochannel definition (same frequency, same spacing). It may be used as the reply code on ZY, since: (1) the Y-channel code is 30  $\mu$ s, (2) adequate frequency protection is provided with respect to the 2  $\mu$ s X channel reply code, because of the frequency separation on the uplink between channel 56X and channel 80 ZY (the selected frequency blocks used in the channel plan), and (3) channel frequency protection with respect to the downlink 12  $\mu$ s X channel interrogation is provided by a distance separation of at least 15 nmi with respect to the reply frequency of channel 80 ZY. This 12  $\mu$ s is not considered an optimum spacing but may be used as described for ZY.

15  $\mu$ s

27  $\mu$ s

33  $\mu$ s - These spacings do not satisfy the 6  $\mu$ s uplink requirement as follows: 15  $\mu$ s with respect to the existing 12  $\mu$ s X-mode and 27/33  $\mu$ s with respect to the existing 30  $\mu$ s Y-mode. Consequently, 15  $\mu$ s may be used as a reply spacing on the ZY channel but 27/33  $\mu$ s is not preferred as an uplink code on the ZX channels only because of its wide spacing and the zero-offset consideration.

30  $\mu$ s - The explanation of possible application on the uplink ZX-channel is equivalent to that for the 12  $\mu$ s spacing on ZY; however, its wide spacing regarding zero-offset is not desirable as an uplink mode.

36  $\mu$ s - The feasibility of possible application on the uplink ZX-channel results because of the uplink ZX-channel frequency separation with respect to the downlink Y channel. However, its wide spacing in an uplink mode is also undesirable for the same reason previously described.

When the design cost criteria of divisibility is allowed, then with respect to the existing uplink spacings of 30  $\mu$ s (Y channels) and 12  $\mu$ s (X channels), the spacings of 15 and 24  $\mu$ s become very desirable codes. Therefore, if 15  $\mu$ s is used as the ZY reply code, then its previous 6  $\mu$ s restriction with respect to the X-mode is removed and can be considered a very satisfactory choice especially with its low spacings value. Consequently, 24  $\mu$ s should be selected as the ZX uplink spacing which must use the same reply frequency as the X-mode of 12  $\mu$ s. The divisibility factor becomes "two," i.e., Y to ZY codes go from 30 to 15  $\mu$ s and the ZX to X codes go from 24 to 12  $\mu$ s. These reply codes are also very adequate in the spacing requirement to provide ample range in the transponder reply delay adjustment,  $\tau_{TA}$ , of:

$$\begin{aligned}\tau_{TA}^{\text{Channel}} &= 50 - \tau_{\text{inherent}} - PS_{\text{reply}} \text{ (Equation 1)} \\ &= 50 - 4 - 24 = 22 \mu\text{s (ZX channels)} \\ &= 50 - 4 - 15 = 31 \mu\text{s (ZY channels)}\end{aligned}$$

Regarding the downlink selection of codes, TABLE E-2 shows the remaining codes yet to be satisfied.

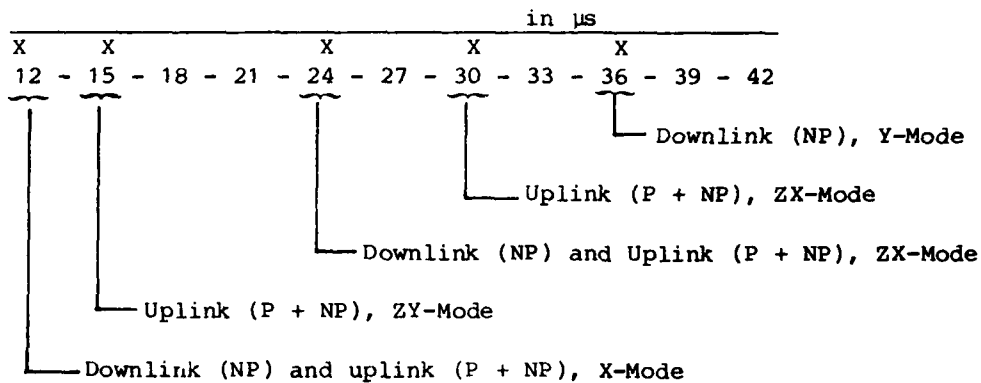
TABLE E-2  
DME/P PULSE CODE SPACINGS ( $\mu$ s)

Channels	Uplink/Downlink	Non-precision	Precision	# of C #
X	Down	12	--	20
	Up	12	12	
Y	Down	36	--	80
	Up	30	30	
ZX	Down	24	--	20
	Up	24	24	
ZY	Down	--	--	80
	Up	15	15	

Since the uplink X and ZX codes (for both precision and nonprecision) must also be the nonprecision downlink coding, 12 and 24  $\mu$ s must be removed

from further consideration for the remaining downlink codes. Also, 36  $\mu$ s is the existing Y-channel nonprecision downlink code while the 15  $\mu$ s spacing, already selected as the ZY uplink mode, is too close to the downlink 12  $\mu$ s X-mode code to be considered any further as to its desirability (limited by the tube-type transponders operating on X-mode).

The remaining available codes are therefore:



spacing. All Y channels (also ZY) operating with this frequency arrangement, however, cannot be assigned closer than 15 nmi to another Y, ZY, X or ZX. Also, this 30  $\mu$ s downlink code is to be used with the precision mode, which requires operation within 7 nmi of the desired site (selected channel), providing an additional desired to undesired signal advantage plus the fact that the assignment of the undesired facility will preclude breaking through the desired transponder receiver above its noise level.

For the sake of providing additional protection, a code spacing was selected at 33  $\mu$ s in lieu of the more desirable design value at 30  $\mu$ s. The precision ZX transponder design should preclude interference from the uplink Y-mode spacing (30  $\mu$ s). Also, 33  $\mu$ s should not interfere with the Y-mode 36  $\mu$ s downlink mode since Y-mode transponders also have the newer solid-state decoders, and because the level of interrogations of the precision 33  $\mu$ s codes should be low in number.

TABLE E-3 is included which shows these selected code spacings as a function of channel type and precision/non-precision code association.

It should be understood that the pulse spacings selected are not unique but are considered a good and safe selection for the DME/P implementation with DME/N.

TABLE E-3  
DME/P PULSE CODE SPACINGS ( $\mu$ s)

Channels	Uplink/Downlink	Non-precision	Precision	# of C #
X	Down	12	18	20
	Up	12	12	
Y	Down	36	42	80
	Up	30	30	
ZX	Down	24	33	20
	Up	24	24	
ZY	Down	21	27	80
	Up	15	15	

CHANNEL IMPLEMENTATION STRATEGY

In order to extend the long-term interoperability of DME/N and DME/P equipments, the working group recognized that a specific channel implementation strategy should be followed. This strategy, detailed as follows, will allow DME/N interrogators to utilize DME/P transponders into the late implementation phases of MLS. In addition, it delays the implementation of the newly defined multiplexed channels until after a period of time when all interrogators and transponders are expected to have better decoder rejection capabilities.

Block Structure

Ten blocks are created by using DME channels paired with the ILS channels and the VOR Y channels.

1. Block I

20 ILS channels with 100-kHz spacing are used; that is, the even X channels: 18 X to 56 X.

2. Block II

20 ILS channels with 50 kHz spacing are used; that is, the even Y channels: 18 Y to 56 Y.

3. Block III

20 VOR channels with 50 kHz spacing in the 112-118 MHz band are used; that is, the even Y channels: 80 Y to 118 Y.

#### 4. Block IV

20 VOR channels with 50-kHz spacing in the 108-112 MHz band are used; that is, the odd Y channels: 17 Y to 55 Y.

#### 5. Block V

20 VOR channels with 50-kHz spacing in the 112-118 MHz band are used; that is, the odd Y channels: 81 Y to 119 Y.

#### 6. Block VI through X, inclusive

Each block is increased twofold with using another code on the same channel that will be: ZX or ZY according to the considered block. So the 200 channels are created.

### Block Implementation Rationale

To implement the DME/P channel plan, a preference to accomplish the block assignments might be as follows.

1. To use Block I assignments at those runways with existing ILS assignments provided, the D/U protection criteria for both the MLS and DME/P are satisfied. This may enable the DME/P to be assigned on the same channel as the DME/N associated with the ILS.

2. If Block I channels cannot satisfy the assignment of MLS-DME/P on an existing ILS channel, an assignment of the MLS-DME/P should then be attempted from the Block II channels. An option here is to either leave the ILS "as is" or reassign it on the same Block II channel as the MLS/DME/P. The latter enables the use of a single DME/P for both the ILS and MLS. Block II channels may also be assigned at those runways without an existing ILS.

3. If additional channels are required after Blocks I and II are expended, then, Block III should be made available for assignment, which enables continuation of the preferred four channel assignment separation to be maintained with respect to the MLS channels.

4. When Block III is expended or as may be required to meet regional needs, then Block IV should be made available. Essentially, the limiting constraint on channel assignment will be the adjacent-channel separation standards for both the MLS and the DME/P.

5. When Block IV is expended or as may be required to meet regional needs, then Block V should be made available. The rationale is the same as item 4 above.

6. Block VI should only be used after all the other blocks have been expended. Block implementation should proceed with the multiplexed Block II first, then multiplexed Block III, Block IV Block V and, finally, the least preferred, Block I.

To reduce the potential for intersystem interference concerning the present en route VOR Y channels being shared with the MLS-DME/P, a recommended procedure for assigning channels to these two services is to proceed with the en-route assignments from the high end of the Y channels using odd assignments only (i.e., 119Y, 117Y, etc.) and to initiate MLS/DME/P from the low end of the Y channels using even channel assignments (consistent with the above block implementation, i.e., 18Y, 20Y,.....80Y, etc.). The requirements for each type service will establish the degree of the Y-channel occupancy. If each of the MLS/DME/P and en route requirements are excessive, which is not believed to be the case, then the MLS/DME/P and en route assignments will become interleaved such that the MLS C-Band will still always maintain a four-channel separation and the DME/P L-Band will always be separated by an adjacent channel.

GUIDANCE MATERIAL FOR THE DEVELOPMENT OF SEPARATION STANDARDS

The channel assignment procedures envisioned for use with MLS angle guidance systems and DME/P are not substantially different from those used today for ILS and DME/N. It is expected that eventually specific desired-to-undesired (D/U) protection criteria can be established based on actual hardware performance. However, until that time, conservative distance separation requirements can be implemented. These interim criteria for the assignment of Blocks I through V are listed in TABLE E-4. Note that these criteria are based on equal transmitter power from the desired and the undesired facilities.

TABLE 4  
INTERIM DISTANCE SEPARATION CRITERIA FOR MLS

TRSB MLS	
Cofrequency	200 nmi
Adjacent frequency	25 nmi
MLS DME/P	
Cofrequency	110 nmi
Adjacent frequency	25 nmi

ATE  
LME